[H.A.S.C. No. 98-60]

BRIEFING ON HUGHES AIRCRAFT COMPANY'S QUALITY CONTROL PROCEDURES

JOINT BRIEFING

OF THE

RESEARCH AND DEVELOPMENT SUBCOMMITTEE

THE

PROCUREMENT AND MILITARY NUCLEAR SYSTEMS SUBCOMMITTEE

AND THE

INVESTIGATIONS SUBCOMMITTEE

OF THE

COMMITTEE ON ARMED SERVICES HOUSE OF REPRESENTATIVES

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4201-5

BRIEFING ON HUGHES AIRCRAFT CO.'S QUALITY CONTROL PROCEDURES

HOUSE OF REPRESENTATIVES, COMMITTEE ON ARMED SERVICES, INVESTIGATIONS SUBCOMMITTEE, PROCUREMENT AND MILITARY NUCLEAR SYSTEMS SUBCOMMITTEE, AND INVESTIGATIONS SUBCOMMITTEE,

Washington, DC, Thursday, September 20, 1984.

The subcommittees met, pursuant to notice, at 2 p.m., in room 2118, Rayburn House Office Building, the Honorable Richard Ray presiding.

OPENING STATEMENT OF HON. RICHARD RAY, A REPRESENTATIVE FROM GEORGIA

Mr. RAY. Gentlemen, the hearing will come to order.

Chairman Nichols is involved in a conference committee. Thank goodness we finally got to it. We think we have the DOD conference back on track. We don't want to do a thing to deter that. He is meeting at this time with the House conferees, and hopefully the Senate and the House conference will begin sometime later this afternoon.

We are here today to examine the quality assurance problems discovered at the Hughes Aircraft Co. plant in Tucson, AZ. First, I want to thank the members of the Research and Development and the Procurement Subcommittees who have joined the Investigations Subcommittee today.

The issue of quality assurance is of concern to the entire committee. What concerns us is that the situation at Hughes may only be the tip of the iceberg. From the statements made by the Department of Defense personnel, it appears there is a widespread belief that the problems uncovered at Hughes are not unique.

This is not a new issue, but the level of concern appears to be greater in recent months as concrete examples of problems continued to surface. Last week the Navy's Deputy Chief of Naval Materiel Command for Reliability, Maintainability and Quality Assurance, raised a new issue. In a speech which was reported in Defense Week, he charged that the Department of Defense is as much to blame as the contractor.

I am concerned about why these problems were allowed to continue for so long before the Department finally acted. I hope you will address these issues in your presentation.

At this time we will call on Colonel Slinkard, who is Deputy Chief of Staff, Contracting and Manufacturing for the Air Force Systems Command, Department of the Air Force, for any statement that you would like to make.

STATEMENT OF COL. JOHN D. SLINKARD, DEPUTY CHIEF OF STAFF, CONTRACTING AND MANUFACTURING, AIR FORCE SYSTEMS COMMAND, DEPARTMENT OF THE AIR FORCE

Colonel SLINKARD. Mr. Chairman, I ask your permission, if I may, to bring forward what we call hard copies of a briefing and pass them out to you, sir, and the other members of the staff.

Mr. RAY. No objection.

Colonel SLINKARD. Sir, I would like to state that apparently I was misinformed or misunderstood, in that I did not believe that I was coming to a hearing as such, but rather a meeting to inform about the situation at Hughes, Tucson.

Mr. RAY. Well, Colonel Slinkard, I think this is a briefing more than it is a hearing.

Colonel SLINKARD. Yes, sir.

What I would like to do then is begin by going through the situation at Hughes as we understand it; and part way through, I will ask Mr. Mike Page from Headquarters, Air Force Contract Management Division, who participated in the contract operations review at Hughes, to show you, sir, if I may, some pictures of the actual quality problems found and at that point, if you would permit him to do it, we would like to have him come forward so he can show them to you and point out the problems.

Mr. RAY. Please proceed.

Colonel SLINKARD. I will cover the chronology of recent events, the contracts affected and the schedule slippage status of the programs at those times.

I will cover the quality issues, as we understand them, and the actions that have been taken by the Air Force, Army, and Navy and where we stand today. If you would turn with me to the chronology, please. A lot has happened over the past 3 months with respect to Hughes quality. On the 6th and 7th of June, the Navy tore down a Phoenix missile and found significant problems in workmanship in that missile. On the basis of that teardown, the Navy procuring contracting officer sent a letter and suspended the acceptance of Phoenix missiles on the 22d of June.

In addition, in order to ascertain how widespread those problems were, the Navy tore down two additional missiles, June 25–27.

The Army tore down a TOW II missile, during July 17 to 24.

The Air Force, which has contract administration cognizance at Hughes, Tucson, instituted a product review of the Hughes missile systems which lasted from July 18 to August 3. A scheduled Maverick missile teardown was moved forward to be done in conjunction with that review.

Based on the results of that review, on the 3d of August, the principal administrative contracting officer issued a notice of intent to disapprove their quality assurance system within 90 days if they did not take the appropriate corrective action and asked Hughes to submit a corrective action plan not later than the 1st of September.

On the 8th of August, the Air Force procuring contracting officer for the Maverick missile suspended further acceptance of Maverick missiles. After consultation between the Army and the Navy and the Air Force, General Skantze, commander of Air Force Systems

Command, sent a letter to Dr. Puckett and announced a joint decision to suspend 100 percent of the progress payments at Hughes on the Maverick, Phoenix, and TOW missiles.

Subsequently, progress payments were suspended on the angle rate bombing set.

On the 21st of August, the principal ACO issued his official notice of intent to suspend progress payments for those programs; and the reason that there was a notice of intent is that we are required and wish to allow the contractor an opportunity to respond.

The principal ACO reviewed that response and did suspend progress payments on the 27th of August.

Hughes, as requested, submitted its corrective action plan on the 31st of August. That plan has been subjected to a joint team review, which I will speak to in more detail later on, and has been briefed to the commander of Air Force Systems Command, the vice commander of Naval Material Command, and representatives of the Army Materiel Command on September 14.

On the 17th of September, the review team briefed the results of its reveiw to the Secretary of the Air Force and to Dr. DeLauer of the Office of the Secretary of Defense. I will reveiw very briefly, primarily by reliance on the charts, the programs affected.

In each case we have shown the buy. For example on the Maverick, whether it is a fiscal year 1982 or 1983 production buy, the target price of the fixed price incentive fee contract, and the quantities being purchased.

Mr. RAY. May I ask a question? On June 6 and 7, when you tore down the Phoenix missile, was that the first time any missile had been torn down at that time, June 6 and 7?

Colonel SLINKARD. To my knowledge that was the first time that the Phoenix missile had been torn down.

Captain Bowes is the Phoenix manager.

Mr. RAY. Others had been?

Colonel SLINKARD. Maverick had been torn down previously. Some probelms were found and corrected. I have shown down at the bottom of the chart that at the point of suspension of acceptance for the Maverick, Hughes was behind 11 missiles in the fiscal year 1982 buy. Those missiles should have been done by the end of July and they were not done on the 3d of August when acceptance was suspended.

The Phoenix programs are shown on the next chart—Phoenix contracts I should say—and we have that Hughes was behind schedule 11 months at the point of suspension of acceptance on the 1981-82 buy and 3 months on the 1983 buy. NTE stands for not to exceed.

On the TOW program, which is on the next chart, that is a fixed-price contract with economic price adjustment, whereas the others were fixedprice incentive contracts. Hughes discontinued final assembly on the TOW without being directed to do so on the 9th of August, and that program was on schedule at the time, sir.

On the following chart, the angle rate bombing set for the Navy is described, and that program also was behind schedule.

Hughes discontinued final assembly and checkout on the 9th of August on that also.

At this time, if I may, I will ask Mr. Page to describe to you the contractor operations review in which he was a major participant, and the findings.

[Colonel Slinkard's charts follow:]

CONTRACTS AFFECTED

MAVERICK (AIR FORCE)

- IR MAVERICK FPIF CONTRACTS
  - FY 82 PRODUCTION BUY (QTY 200)
    - TARGET PRICE $99.8M
  - FY 83 PRODUCTION BUY (QTY 900)
    - TARGET PRICE $163M
- LASER MAVERICK FFP CONTRACT
  - FY 83/84 PRODUCTION BUY (QTY 255)
    - FFP $79.4M
- VERBAL SUSPENSION OF ACCEPTANCE 3 AUG 84
- AT THE POINT OF SUSPENSION BEHIND SCHEDULE 11 MISSILES FOR FY 82 BUY (3 DAYS)

CONTRACTS AFFECTED CONTINUED

PHOENIX (NAVY)

- FPIF CONTRACTS
  - FY 81/82 PRODUCTION BUY (QTY 132)
    - TARGET PRICE $193.4M
    - BEHIND SCHEDULE 11 MONTHS AT POINT OF SUSPENSION
  - FY 83 PRODUCTION BUY (QTY 108)
    - TARGET PRICE $114.8M
    - BEHIND SCHEDULE 3 MONTHS AT POINT OF SUSPENSION
  - FY 84 ADVANCED BUY (QTY 265)
    - NTE $58M
- SUSPENSION OF ACCEPTANCE 22 JUN 84

BRIEFING BY COL. JOHN D. SLINKARD

CONTRACTING AND QUALITY ISSUES

HUGHES MISSILE SYSTEMS GROUP
TUCSON, ARIZONA

OVERVIEW

- CHRONOLOGY
- CONTRACTS AFFECTED & SCHEDULE SLIPPAGE
- QUALITY ISSUES
- ACTIONS TAKEN

CHRONOLOGY

6-7 JUN:	PHOENIX MISSILE TEAR DOWN
22 JUN:	NAVY PCO LETTER SUSPENDS ACCEPTANCE OF PHOENIX MISSILES
25-27 JUN:	PHOENIX MISSILE TEAR DOWN
17-24 JUL:	TOW II MISSILE TEAR DOWN
18 JUL- 3 AUG:	PRODUCT REVIEW OF HUGHES MISSILE SYSTEMS GROUP
23-27 JUL:	MAVERICK MISSILE TEAR DOWN
3 AUG:	PACO NOTICE OF INTENT TO DISAPPROVE QUALITY ASSURANCE SYSTEM
8 AUG:	AIR FORCE PCO LETTER SUSPENDS ACCEPTANCE OF MAVERICK MISSILES
17 AUG:	GEN SKANTZE LETTER TO DR PUCKETT -- 100% PROGRESS PAYMENT SUSPENSION
21 AUG:	PACO NOTICE OF INTENT TO SUSPEND PROGRESS PAYMENTS FOR MAVERICK, PHOENIX AND TOW MISSILES
27 AUG:	PACO SUSPENDS PROGRESS PAYMENTS
31 AUG:	HUGHES SUBMITTED CORRECTIVE ACTION PLAN
14 SEP:	HUGHES AND JOINT REVIEW TEAM BRIEFED AFSC, NAVMAT AND AMC COMMANDERS
17 SEP:	JOINT REVIEW TEAM BRIEFED SECAF AND OSD

CONTRACTS AFFICTED CONTINUED

TOW (ARMY)

- FP CONTRACT WITH EPA
  - FP $287.6M (QTY 21,621)
- HUGHES DISCONTINUED FINAL ASSEMBLY AND CHECK-OUT 9 AUG 84
- ON SCHEDULE

CONTRACTS AFFECTED CONTINUED

ANGLE RATE BOMBING SET (ARBS) (NAVY)

- ARBS FOR A-4 AIRCRAFT
  - FY 78-82 PRODUCTION BUY (QTY 120)
    - FPIF $55.2M
    - LAST DELIVERIES OF 40 WERE DUE JUL 84
- ARBS FOR HARRIER AIRCRAFT
  - FY 82 PRODUCTION BUY (QTY 18)
    - FPIF $10.2M
    - LAST DELIVERIES OF 3 WERE DUE DEC 83
  - FY 83-86 PRODUCTION BUY (QTY 204)
    - LETTER CONTRACT NTE $130M
    - DELIVERIES WERE SCHEDULED TO START SEP 84
- HUGHES DISCONTINUED FINAL ASSEMBLY AND CHECK-OUT 9 AUG 84

STATEMENT OF MICHAEL W. PAGE, CHIEF, MISSILE, ELECTRONICS AND SPACE DIVISION, DIRECTORATE OF OPERATIONAL REVIEW, HUGHES MISSILE SYSTEMS GROUP, TUCSON, AZ

Mr. PAGE. The fifth bullet on that chart showing the chronology of events talks about the product oriented review. I was the AFSC team chief on that review. I led a team of a total of eight people out there for 2½ weeks.

The next chart gives an overview of what I will talk to you about, the team charter, which is after that, and the composition findings by program. When I start talking about the findings by program, I would like to come up, if I may, and show you some color photographs of examples of the types of quality problems that we have hand at Hughes in recent months.

On our team charter chart, the last sentence is very significant. The validation of all findings with contractor personnel. This took place on a real time basis while we were doing the review. We would have the product in one hand, the drawing in the other had, and a contractor counterpart standing beside us, so there was no subjectivity in the review itself. We were basing our findings on hard contract requirements and the contractor was there to validate that those were valid requirements.

In every case, we picked up hardware after the contractor had inspected it and the Government had accepted that hardware. We didn't pick up hardware in between the inspection process. It was after inspection operations had taken place and the hardware had been bought, which is the terminology used for the inspection process. We looked at it after that.

During the validation process, by the way, the contractor was very cooperative and motivated by this process because in the past there had been some reviews in there that were not necessarily against contract requirements. This was not the case with this review.

On the team membership chart, I want to emphasize that these were all Government people with diverse backgrounds on this team. Four of the people on this team, from 1969 until 1983, actually worked at the AFPRO down there: myself, Jay Newman, Jim Mathenia, and Don Splat were actually quality assurance representatives within the contract management division at AFPRO Hughes, Tucson. We had a good feel of what had gone on there over the past years, products, what they had built, how the process worked, and so forth.

One thing was interesting to note during the review. To a man, these three guys came to me—Mr. Newman, Mr. Splat, and Mr. Mathenia and told me when they had left Hughes, Tucson, back in the 1970's and up until 1983 when the last one transferred out, that they had not seen the types of things that we were seeing. They had gone to new jobs in the Government at various AFPRO's using Hughes as the standard to which to judge industry by and that was not the case any more.

They were very, very surprised—couldn't believe that things had changed that much since they were there. They thought this was the contractor who did business the way they should.

The findings by program, we had a total of 68 findings, validated findings with the contractor. Now, what that 68 finding means is that there were actually 227 defects found. One findings might have 3, it might have 5, it might have 10 defects written on that one finding, and you can see the breakout by the various programs.

If I may, I have some pictures here—we didn't take these during our product review but they are representative of the type of quality problems we saw down there. If I could bring those forward. I need to explain them to you as I go.

In this picture here there is a wire clipping stuck to the bonding material. As I said before, these were missiles, this hardware was all bought before we ever looked at the inspection—a wire clipping stuck to the bonding material.

They are not in any particular sequence. In this picture here there is a piece of rigid coaxial cable rubbing a surface. The way these missiles are used, they are put on the aircraft, the aircraft flies, they land, they fly, they land. They live in a high vibration atmosphere. Over a period of time this is going to cause you problems as far as reliability.

Now, this sort of defect here is a rub on this rigid coaxial cable, which eventually will go all the way through.

Here, for example, is what happens when you have an abrasion on coaxial cable. This unit has an aluminum skin that goes over it. This was out too far so it contacted this aluminum skin. So, during a high vibration flight type mode, eventually you have the opportunity to vibrate through.

This picture here is a hydraulic line on the back of a hydraulic pump. As you can see, it is touching a metal surface there.

This picture is a safety wire. You can look right there. That safety wire is broken so you have lost the safety wire that you need at that point.

We found a case where there is no lock washer. You can see a thumb pushing this down. This had a screw that vibrated loose, just moving around the factory floor. In normal operation, what eventually would happen is that it would vibrate all the way out and migrate wherever it happened to end up inside the missile.

You can see in this picture these are coaxial cables. The routing of this is such that when you put the skin on, the skin fits on these holes right there. This wire particularly would be laying against this sharp edge. You can see how sharp the edge is.

MIL-STD 454, which is the general requirement for workmanship, states you cannot have a coaxial cable rubbing on sharp edges.

You would need a piece, this particular piece of white stuff here, this shielding, you would need something like that at that point to protect that cable, so when it did vibrate you would have a piece of shielding so it didn't vibrate through on the sharp edge.

Mr. KRAMER. Is that all contained?

Mr. PAGE. MIL-STD 454 does not allow you to route cable over sharp edges.

Mr. KRAMER. You have additional parts?

Mr. PAGE. No, sir; you just move the shielding. You simply move that shielding up to this edge where that wire was going to lay. That would solve that problem for you. That is what the shielding

is for. In this particular case here, you have a lack of stress relief. As you can see, the shielding on this particular cable is broken because it comes out, makes a hard turn and it doesn't have the stress relief. What that will do in a high vibration environment is eventually you will have a problem with that piece of wire.

That is the back of a circuit board, and you can see there was a screw installed there, another one installed there. When they installed the screw here it went through the cable itself. This one here pinched it. That is eventually going to cause you reliability problems.

These are different missiles. Here is the back. These are two different missiles that were torn down. The back of this connector here you can see a metallic particle. Once again, these particular pictures are the two that were torn down.

Mrs. BYRON. Did you tear down more than two?

Mr. PAGE. Three were torn down in total. These are the second two.

Mrs. BYRON. This is the third one?

Mr. PAGE. The first one I don't recall whether they took pictures or not.

Mrs. BYRON. On the third one were there problems?

Mr. PAGE. There were similar problems on all the missiles torn down.

Mrs. BYRON. What do you do——

Mr. PAGE. Here is a metal particle on this one. On this circuit board here you can see the discoloration on these two leads. That is because the flux was not removed after operation was performed, a rework operation in this particular case, I imagine. That flux is supposed to be removed. This is what we call a solder ball. In soldering a joint splice, a piece of solder fell off, and that is the way it was when the missile was opened up. This is an example of a poor solder joint. This wire is not connected with that pin as it should be.

Here is an example of some rework being done. All these boards are conformal coated. You are supposed to take the conformal coating off. As you see it was not removed before that was done. A matter of poor workmanship.

Then on the last picture, on this circuit board, another metal particle down within the circuit board. You can see by the length of the metal particle it is long enough to get in between a couple of pins.

Those were not the pictures of the product review we did, but for simplicity, in trying to explain it to you, to be able to show you representative examples, we have shown you these pictures. We found in the 68 findings with 227 defects, similar problems to this.

Our conclusion chart. We were told when we were briefed by the contractor that they expected us to find two fairly different situations there. They had the Phoenix and Maverick programs which were undergoing new changes, new hardware being built, very dense electronics.

The other end of the spectrum was the Army's TOW missile, which is a very, very simple piece of hardware and they expected us to find the TOW in very good shape and to find a few problems

with the Phoenix and Mavericks because of where they are in production and sophistication of the hardware.

In fact, we found exactly the same problems across all the programs. Now, the workmanship pictures give you representative examples. One of the major problems we found there was the engineering to planning translation. In the picture I showed you with the lack of a screw, the drawing showed a screw, the planning didn't show that. The drawing showed a washer under there, the planning didn't show the washer.

MIL-STD 454 once again, was not implemented. Specifications on contract were not implemented in the planning.

On the operator compliance to planning, we found a good portion of the problem here was that because of the different types of hardware they build. For example, the Phoenix and Maverick being densely packed and very highly sophisticated; TOW not being so sophisticated. The operator one week might be working on Phoenix and a month later might be working on TOW, and the eye calibration of what is acceptable and what is not acceptable is probably part of the problem. You can just about do your soldering with a blow torch on the TOW program, but it is a pretty sophisticated process on the Maverick and Phoenix programs because of the different types of hardware being used.

The findings that we came up with during the product review did, in fact, verify the previous concerns of the Army and Navy, that there was suspect hardware being built by Hughes Tucson. With the independent review we had no axe to grind for any particular program office. We can out with exactly the same opinion they did.

The last bullet there is about the quality of the work force. One of the things we noticed during the review, especially on the TOW program, which was the high rate—120 to 150 a day type program, and everytime we would find something wrong—seven times during the review we found problems that would shut down the program—instead of the quality assurance folks going out and doing what a quality assurance guy is supposed to do, which is stop bad hardware, they would get in a huddle with the manufacturing guys and try to come up with a consensus on what they should do about it.

We understand that has since changed. Quality has some backing down there and things are happening the way they should.

I will now turn it back to Colonel Slinkard.

PREPARED STATEMENT OF MICHAEL W. PAGE

PRODUCT REVIEW OF HUGHES MISSILE SYSTEMS GROUP

HUGHES MISSILE SYSTEMS

HUGHES MISSILE SYSTEMS GROUP

MANUFACTURING DIVISION AND MISSILE OPERATIONS DIVISION
TUCSON, ARIZONA

OVERVIEW

- TEAM CHARTER
- TEAM COMPOSITION
- FINDINGS BY PROGRAM
- CONCLUSIONS

TEAM CHARTER

PERFORM A REVIEW OF HARDWARE FOR THE PHOENIX, MAVERICK, AND TOW PROGRAMS USING CONTRACTUAL REQUIREMENTS AS THE BASIS FOR THE REVIEW. ASSURE THAT THE HARDWARE REVIEWED MEETS THE DRAWING/SPECIFICATION REQUIREMENTS OF THE CONTRACT. VALIDATE ALL FINDINGS WITH CONTRACTOR PERSONNEL.

TEAM MEMBERSHIP

ED WESTCOTT	HQ AFSC
MIKE PAGE	HQ AFCMD
P. T. ANDERSON	HQ AFCMD
JOHN CARDMON	HQ AFCMD
JAY NEWMAN	AFPRO THIOKOL
JIM MATHENIA	AFPRO RI COLUMBUS
DON SPLAT	AFPRO WESTINGHOUSE
CHUCK STUMP	AFPRO WESTINGHOUSE
PETE CAVANAUGH	AFPRO WESTINGHOUSE

FINDINGS BY PROGRAM

TOTAL FINDINGS	68
PHOENIX	19
MAVERICK	26
TOW	23

CONCLUSIONS

- ALL PROGRAMS REVIEWED DISPLAYED SIMILAR FINDINGS
  - WORKMANSHIP
  - ENGINEERING TO PLANNING TRANSLATION
  - OPERATOR COMPLIANCE TO PLANNING
- FINDINGS VERIFY PREVIOUS CONCERNS OF CUSTOMERS
- QUALITY WORKFORCE NEEDS SPECIFIC DIRECTION/BACKING

RATIONALE FOR STOPPING PROGRESS PAYMENTS

- REASON FOR SUSPENSION:

  FAILURE OF THE CONTRACTOR TO COMPLY WITH THE MATERIAL REQUIREMENTS OF THE CONTRACT, SPECIFICALLY MIL-Q-9858A QUALITY ASSURANCE REQUIREMENTS

- PURPOSES:

  PROTECTION OF THE INTEREST OF THE GOVERNMENT AND TAXPAYERS

  FOSTERING SATISFACTORY CONTRACT PERFORMANCE

- BASIS:
  - TEAR DOWN OF PHOENIX, MAVERICK & TOW MISSILES
  - AFCMD PRODUCT ORIENTED REVIEW CONDUCTED 18 JUL - 2 AUG 84.
  - AFPRO INTERNAL MANAGEMENT INDICATORS

ESSENTIAL ELEMENTS OF THE PLAN

- MIL Q 9858A - QUALITY PROGRAM REQUIREMENTS
  - GROUP WIDE PLAN
  - PROGRAM UNIQUE REQUIREMENTS PLANS
  - DEFECT REDUCTION/PROCESS CONTROL PLAN (BUILT-IN QUALITY)

JOINT REVIEW

- 30 AUGUST REVIEW IN PLANT
- 31 AUGUST REVIEW AT CMD HEADQUARTERS
- 4 SEPTEMBER SENIOR ADVISORY GROUP REVIEW
- 14 SEPTEMBER HUGHES AND JOINT REVIEW TEAM BRIEFING TO AFSC, NAVMAT AND AMC COMMANDERS
- 17 SEPTEMBER JOINT REVIEW TEAM BRIEFING TO SECAF AND OSD

JOINT REVIEW TEAM

SUMMARY

- CONTRACTOR PLAN NEEDS ADDITIONAL EMPHASIS ON DEFECT REDUCTION/PROCESS CONTROL (BUILT-IN QUALITY)
- GOVERNMENT REVIEW PROCEDURES IN PLACE
- TIE PROGRESS PAYMENTS TO CONTRACTOR DEMONSTRATED IMPROVEMENTS
- MANAGEMENT BY HUGHES OF SUBCONTRACTOR QUALITY NEEDS EMPHASIS
- HUGHES DIRECTED TO RESUBMIT BY 30 SEPTEMBER

REASON FOR SUSPENSION OF PROGRESS PAYMENTS

Colonel SLINKARD. I want to review just briefly the reason for suspension of the progress payments, which mostly you can get from what Mr. Page said. We considered jointly that there was a failure of the contractor to comply with material requirements of the contract, specifically MIL Q-9858A quality assurance requirements, which is the watershed document that lays out what a contractor's quality assurance system is supposed to be like and places the fundamental responsibility on the contractor for having a quality assurance system adequate to meet all contract requirements.

Our purposes were protection of the interest of the Government and the taxpayers—that is, we should not continue to pay progress payments at that point in the face of these kinds of problems when we could not be sure that the progress being made from the incurrence of those costs was producing quality hardware, and also to foster satisfactory contract performance. That is, to motivate Hughes to correct its problems.

The basis is shown here. The teardowns, the product oriented review, and the findings of the AFPRO in its day-to-day business. Hughes did indeed submit its corrective action plan on the 31st of August. There has been substantial joint review of that plan. I will go into it in a moment. The plan is really in several parts.

Hughes has very responsively addressed the specific concerns raised by the Air Force and the other services. They have done things like they stopped final assembly. They went back and are recertifying all their final assembly work groups, having all the specifications, work procedures, all the things that are necessary to assure an orderly and repeatable and accurate process revalidated.

They have also picked new and earlier inspection points and have looked back at the engineering—I should say they are in the process of doing those things—I don't mean to imply that they are completed.

In addition, Hughes came up with program unique plans for the Phoenix, TOW, and Maverick which were reviewed by the independent program managers to see that those would be responsive to the needs of their programs. They also came in with another part of the plan which really seeks to address the long-term situation—how do you systematically improve your process, your process control, and build quality into the manufacturing process as opposed to trying to test and inspect quality in at the end.

That involves such things as relaying out production facilities, cleaning out the microcircuit facility, and putting in new facilities, and so forth. So those are the essential elements of the plan.

As I said earlier, there has been a joint review of the Army, Navy, and Air Force and to some extent, DLA. The plan was briefed on August 30 in the plant at Tucson with joint service representatives. It was briefed again at Air Force Contract Management Division headquarters, to Brig. Gen. Donald Stukel, commander of that organization, also with representatives of the other services, on the 31st of August.

On the 4th of September, it was reviewed by the high level quality people, the quality civilians who are really expert in all of the services. Mr. Wescott from the Air Force, Mr. Don Moore, who is

Chief of Quality in DLA, Mr. Will Willoughby from the Navy and Mr. Sy Lober from the Army.

We wanted those high level civilians to take a good look at this plan. On the 14th of September, as I mentioned earlier, it was briefed to the commander of the Air Force Systems Command, the vice commander Naval Material Command and representatives of the Army Materiel Command commander, and then it went forward to the Secretary of the Air Force and the Office of the Secretary of Defense.

Now, if you turn with me, a summary of what the joint review turned up is that with respect to the third thing I mentioned, the systematic correction, the joint review indicated that Hughes needed to improve that plan to get more in-process control and built-in quality assurance, and as it says down at the bottom of the chart, Hughes was given until September 30 to resubmit that element of the plan. They are working on that now.

The Government review procedures, in terms of how the plan will be carried out, are in place and I will summarize those briefly.

Hughes will have a control room at Tucson that shows all their milestones and all the things they are supposed to do, and the Air Force plant representative office and visitors from the program management offices will have access to that control room, will be able to see it.

There will be a weekly review at the Air Force plant representative's office level; there is a standing committee to track this at the Air Force Contract Management Division Headquarters, and the commander of the Air Force Contract Management Division will review the progress monthly; and then there will be a quarterly review by those high level quality civilians that I mentioned earlier who had gone over the plan.

So the intent is to track this to make sure it happens. We do intend to tie progress payments to contractor demonstrated improvements.

One other thing that we felt needed additional emphasis, that Hughes is working on, is their management of subcontractor quality—how they make sure what comes in the door from their subcontractors is of the proper quality.

Sir, that completes my remarks that I planned to make.

Mr. RAY. Well thank you.

I have just a couple of questions and then the other committee members may ask questions.

On May 19, 1982, Mr. Fitzgerald sent a memorandum to his Air Force superiors, detailing what he thought were serious problems at Hughes. My question is, did the Air Force check to determine whether Mr. Fitzgerald's statement—which included a comment that it took Hughes employees 17 hours to do 1 hour's work—was accurate. Was anything done as a result of the memorandum and, more precisely, do you know what else he said in the memorandum?

Colonel SLINKARD. Starting with the last question first, I don't know precisely what else he said in his memorandum. I do not know whether it was a direct result of his memorandum or not, but there was an extensive study of Hughes productivity, not so much

quality assurance, but productivity, work measurement, realization factors to standard, and the efficiency of Hughes.

That was done back in 1982, and that study was done by the Air Force Contract Management Division; and if you would like some insight into that study, I have my Director of Manufacturing, Mr. Charles Hooper, here who was a participant in the study and is knowledgeable in what was found and what happened after that.

Mr. RAY. We would like to hear from him.

Mr. HOOPER. Charles H. Hooper, Director of Manufacturing, Air Force Systems Command.

I led the team effort in December 1982, at Hughes, Tucson with the primary intent of determining if Hughes had the capability to produce all of the DOD production weapons that are known out in the outyears. As a part of that study, to look at production capability, we also looked at efficiency and productivity issues, one of which was the labor efficiency that I think you just referred to, that Mr. Fitzgerald had reported as being 17 to 1.

In December 1982, the production number of Hughes' performance to labor standard on IIR Maverick at that time was about 17 to 1. We also reported labor efficiencies on the other programs in Hughes. At that time they had Phoenix, TV Maverick, and TOW. The study results were briefed up to the Secretary of the Air Force and Hughes was requested to produce a corrective action plan, which they produced in April of 1983.

We considered the plan to be inadequate, made a followup study in August of 1983, found that the condition had not improved significantly, and the Secretary of the Air Force asked the Hughes managment to come and meet with him personally. As a result of that, in December of 1983, Hughes produced a productivity improvement plan in which they set milestones for improving the labor efficiency of those programs

Since that time, they have provided two status reports to that plan. We have been monitoring, checking that plan. The labor performance has improved significantly on all those programs since that date.

Mr. RAY. Thank you, sir.

Mr. HOPKINS. Thank you, Mr. Chairman.

Colonel, what does one Phoenix missile cost, approximately, in round figures?

COST OF PHOENIX MISSILE

Colonel SLINKARD. Approximately $1 million in the fiscal year 1983 production buy. But I would like to defer to the Phoenix program manager.

Mr. HOPKINS. That is all right, just approximately is close enough.

Colonel SLINKARD. $950,000 for a Phoenix in the fiscal year 1983 production buy.

Mr. HOPKINS. What about Maverick, what does one Maverick cost?

Colonel SLINKARD. If my math is correct, about $180,000.

Mr. HOPKINS. $180,000. What about a TOW missile?

Colonel SLINKARD. I am not sure that I decipher quickly enough to get that off of this chart, but it is very, very much less than the other two.

Mr. NEWHART. Gary Newhart. Around $10,000.

Mr. HOPKINS. Let me ask you this, how many Phoenix missiles do we have in inventory today?

Colonel SLINKARD. I don't know how many Phoenix missiles we have. I am sure the program manager does.

Captain BOWES. We currently have accepted or have in inventory about 124 Phoenix-C missiles, although they are not in the active inventory, since the Navy has not yet deployed the Phoenix to the fleet—a Phoenix-C to the fleet.

We do have the AIM-54A or Phoenix-A deployed in the fleet.

Mr. HOPKINS. Those 124 Phoenix missiles have been accepted from Hughes, is that correct?

Captain BOWES. 124 are currently in the Hughes bunker or being tested by the Navy.

Mr. HOPKINS. How many Maverick missiles do we have in inventory?

Colonel SLINKARD. There is a small number of IR-Maverick, infrared Maverick, in development testing. So it is an initial production run, not a large number. I think it is about 17.

Mr. HOPKINS. About 17, is that what you said?

Colonel SLINKARD. Yes, sir; there are substantial laser Mavericks in the inventory. I meant to say TV Mavericks that were built before. I can get you the specific numbers.

Mr. HOPKINS. When you talk in generalities, what are you talking about now? You have 17 infrared; and, in general, how many Maverick missiles that are not infrared do you have in inventory?

Colonel SLINKARD. I don't have the number.

Mr. PAGE. 20,000.

Mr. HOPKINS. What about TOW missiles?

Colonel SLINKARD. 22,000 TOW II missiles.

Mr. HOPKINS. TOW missiles?

Colonel SLINKARD. Yes.

Mr. HOPKINS. Let me ask you this. How many of the inventory missiles would possibly come under the area of having a problem of which you have found in your 68 findings? How many of the 124 Phoenix missiles, 20,000 Mavericks, and 22,000 TOW's would have problems?

Colonel SLINKARD. I don't think that we know that. I don't mean just that I don't know. I don't think anyone knows that right now.

For example, when the Army accepts TOW missiles they go through a shooting process where they take a sample of that lot of missiles, shoot those missiles, and use that as a basis for accepting, but that does not necessarily mean that just because a missile fired at the time you accepted it, that it is free from the kind of defects that Mr. Page was describing some of which might not show up until through wear, tear vibrations, et cetera.

I am not in any way trying to avoid your question. I think that each program manager will have to address that question and make an assessment for his program based upon that design and the best information that he can get of what is the best method for ascertaining the answer of that for his particular program.

Mr. HOPKINS. My time is up. I have a lot of questions I would like to ask. I wonder if I could ask unanimous consent for one more question?

Mr. RAY. Without objection.

Mr. HOPKINS. Colonel, as director of contracts and manufacturing for the Air Force Systems Command, and an expert in your field, how confident would you be on firing any of these missiles that are now in inventory, knowing of the problems that have been found? Do you have great confidence in our inventory?

Colonel SLINKARD. Well, as you pointed out, my expertise is in contracting, not in engineering, not in firing missiles. I at this point have no reason to believe that one should assume that these problems go all the way back as far as Hughes has been building missiles. I don't think there is evidence of that.

My belief is that in the recent past, as Hughes Tucson built up rapidly in its workload and has hired 2,200 additional personnel over the last several years, and had to train those people, that it is probably in that time period that we need to be most concerned, and I believe that also is consistent with the information Mr. Page gave you earlier in terms of his discussions with the quality people there.

But I believe that, I am confident that, each program manager—TOW, Phoenix, Maverick, angle rate bombing set, will be, and is, addressing himself to that question, and will make an assessment for his program based upon his design, his method of acceptance, how much teardown and all of those things, and he will have to make his own confidence assessment in a manner that is supported by the leaders of his service.

Mr. HOPKINS. Thank you very much.

Mr. RAY. Mr. Courter.

Mr. COURTER. Colonel, how many Air Force people at the Tucson plant are involved in inspection or review of the whole process in the manufacture of missiles?

Colonel SLINKARD. At Tucson there are slightly over 100.

Mr. COURTER. One hundred people at Tucson from the Air Force?

Colonel SLINKARD. About 30 of those—it was about 30—some have been added as a result of these problems, about 8 have been added on temporary duty basis, but roughly about a third of those 100 people are what we would call quality assurance personnel, people whose main duty is quality assurance.

Mr. COURTER. And they have been there since the inception of these programs, is that correct, particularly the Maverick program?

Colonel SLINKARD. Yes, sir; that is correct.

Mr. COURTER. So there were about 30 people involved in quality assurance from the Air Force there since the inception of the program and, as we can see, there are big problems over there. Do you know what they did, what they didn't do? My point is, I guess, were they negligent in not observing some of these faulty operations long before this?

Colonel SLINKARD. What they did do, and do do—and I may ask Mr. Page to supplement what I am going to say because he has been a quality assurance representative—they review the contractor's system for quality assurance. They do do inspections of the

contractor's work, but they do not inspect each and every operation of the contractor's work. In other words, inspections are at selected points. They check on the contractor's inspection system and they have found problems before, but not of the same magnitude.

Mr. COURTER. Did they red flag anything? Is that a practice which is done?

Colonel SLINKARD. Yes, sir; the system that is done is there is a form 21, which is a discrepancy report, which says I found this and it wasn't right, and that is conveyed to company management. There is also under the Contractor Management Systems Evaluation Program a thing called an AFCMD form 47, which says in effect, in the process of reviewing the contractor's written system and procedures and his compliance with that written system and procedures, either the procedures are not correct or they are correct, but not being complied with. I do not—having not been in Air Force contracting management now for about 10 years, it is a suborganization under the Systems Command Headquarters at which I now am—I honestly do not feel competent to make the judgment sitting here today and say here are five people who are negligent or not.

Mr. COURTER. OK, I understand you don't want to give an opinion as to whether they are negligent or not?

Colonel SLINKARD. Yes, sir.

Mr. COURTER. But during the production of Maverick, let's say, where the Air Force has greater interests than the other systems, were people from the Air Force there inspecting the systems at the same time finding something wrong with them? Was it over a period of years?

Colonel SLINKARD. Well, we find some things wrong at every contractor.

Mr. COURTER. Is there such a thing as red flagging?

Colonel SLINKARD. Yes, sir; a quality assurance inspector if he sees something——

Mr. COURTER. Is supposed to red flag it?

Colonel SLINKARD. Yes, sir; he can stop that process.

Mr. COURTER. Did that ever happen there?

Colonel SLINKARD. I am sure it did.

Mr. COURTER. It did happen?

Mr. PAGE. Yes, sir; over the years you find a process that is out of control or something that is not right, you write a form 21.

Mr. COURTER. How many times, let's say in the past 3 years, was there a red flag placed on individual missiles at Hughes, Tucson?

Mr. PAGE. The surveillance we do is not necessarily on an individual missile. It is on the process as you build up to that missile. They build circuit boards.

Mr. COURTER. The question was very clear. The question was, in fact, how many times was a red flag placed on a product during the past several years on those systems?

Mr. PAGE. On a product, numerous times. On a missile, probably never. A missile is incased in such a way you can't see anything. The real guts of what you are doing for a living are down inside that missile in the lower level.

Mr. COURTER. The inspectors from the various services, that are at Phoenix I take it there are more than just Air Force people there. I imagine there are Navy and Army, people as well?

Colonel SLINKARD. Not resident there.

Mr. COURTER. So it is the Air Force inspecting all three systems, all three missiles?

Colonel SLINKARD. Yes, sir.

Mr. COURTER. Do they actually walk up and down the production line to assure quality control? We saw the pictures—faulty wiring, just not properly tightened or something on the screws that should have held them down, wires exposed to sharp edges without the proper coating or protection. That would be found out by onsight inspection. Is it the job of these Air Force people to onsight inspect?

Mr. PAGE. Yes, sir.

Colonel SLINKARD. That is certainly part of their job. As I mentioned earlier, the first responsibility for the quality product goes with the contractor and the contractor is supposed to have a system that assures it. The Air Force people in this case, or the DCAS people in other cases, or the Army people in other cases, depending upon who has what we call plant cognizance responsibilities, are there to ensure that the contractor system is proper, that it does work and to check on it by looking at things.

I do not want to leave you with the impression that each time some lady solders something that she stops after the soldering operation and calls an Air Force inspector.

Mr. COURTER. I understand that does not happen.

Colonel SLINKARD. A great deal goes on and goes into higher assemblies without an eyeball Government inspection taking place. One of the things that has been done is there are a great many more mandatory Government inspections at Hughes, Tucson than there were previously.

Mr. COURTER. I know my time is up but let me sneak in the last question. The response to an inquiry by Congressman Hopkins wasn't clear to me. What are you going to do with regard to those missiles that are in inventory now? The assumption is, if there was poor workmanship, bad quality control with regard to the ones that you tore down, that there is every reason to believe that same poor standard of workmanship existed in the production of those missiles that you now have in inventory; that is, now what are you going to do?

Colonel SLINKARD. We will have to make an assessment of—whether you bring them all back, which would be extremely expensive——

Mr. COURTER. Well, if they don't work, lives depend on this, and what I saw there certainly frightens me. I think your statement is correct that these problems are perhaps not going to be revealed if you test them because they would be revealed over a period of time when there is stress or vibraton, et cetera.

The only thing you can do is bring them back; and, if so, are you going to ask Hughes to do it and pay for it or are we going to do it?

Colonel SLINKARD. Our intent has been and was conveyed to Dr. Puckett by General Skantze and it was stated in a hearing last week by General Skantze and Admiral White. We intend not to

have the Government pay for correction of the quality system itself, for correction of defects in a thing already built that must now be redone, or for correction of subcomponents or subassemblies to the degree that they have been done and now need to be redone.

At the risk of confusing that, I want to say that as Hughes improves its systems and goes about something in a different way and does it right the first time, we obviously will pay for that under the contracts, but our position is that we are not going to pay, to the degree that we have the legal ability to not pay, to fix things that represent a failure of Hughes management to have in place and in force a quality assurance system that would assure that all contractual requirements are met.

Mr. NICHOLS. Mr. Kasich.

Mr. KASICH. Mr. Chairman, thank you.

I have one question. I don't have the article in front of me but I wonder if you would care to comment on an allegation in a newspaper in Arizona that argues that the Air Force, in fact, has had some quality assurance problems internally, and that in fact when notified as to the problems that existed out there, chose not to move forward as quickly as possible.

Colonel SLINKARD. I have not read the article to which you refer. I am not clear as to the term quality assurance problems internally, sir.

Mr. KASICH. That your people were not doing the job properly and that they weren't competent. Do you have any problems with the people who were working out there who should have inspecting and finding these things? Are you satisfied that they did the last job they should? Are you satisfied that they continue to work on other systems and that they were competent, and when they first become alerted to the problem they acted immediately?

Colonel SLINKARD. I am not confident when they were first alerted to the problem they acted immediately. I wasn't there.

General Stukel, commander of the Contract Management Division, has made some changes in organization and supervisors, and has supplemented the quality assurance work force and is taking additional actions to beef up the quality assurance capability at Hughes, Tucson; and I do want to state though, if I may, that whatever problems the Air Force may or may not have had—and I am not making an assessment of that here—that does not relieve Hughes management from having proper quality assurance.

Mr. KASICH. I understand that. What I am asking is how did we become aware of this problem, these defects.

Colonel SLINKARD. There were defects found in looking at the contractor's system and so on, but the proximate cause of what we are talking about today—evidence rather than cause—was the teardown of the Phoenix missile on June 6 and 7. That is when we began to see completed products.

One of the things that I think is perhaps not made clear, and I am not sure I can quantify this for you, is that there was a process by which Hughes had been told about various quality problems, they were trying to correct those quality problems. We think now looking back that they tended to try to do the correcting by making fixes in the product at the end of the process rather than making it right the first time.

Mr. KASICH. The essential question that my constituents, or I think many Members, might have on their mind, is how is it possible that we built missiles that were defective without the people who were inspecting the program finding it? That would be like building an airplane wing that didn't work. How can the process get along that far without somebody inspecting carefully enough to discover that there consistently have been problems with these missiles? Don't you have people who are on the line that look and inspect; and if you do, how could this have happened?

Colonel SLINKARD. We have people who are on the floor. As I said earlier, they don't inspect every single operation or every solder joint, et cetera. I don't want to give you the impression that the Air Force thought quality was great at Hughes, Tuscon, and everything was fine until June. That is not the situation, but the problems had not arisen to a point that demanded the kind of drastic action we took this summer.

Mr. KASICH. You had discovered the defects in this missiles, in June. My question is when were those constructed? What was the date that those three went through the assembly line and came off as completed?

Mr. PAGE. I don't know the dates—6 months before, I think roughly—6 months to 1 year before.

Captain BOWES. In July.

Mr. KASICH. So in July of 1982, those——

Captain BOWES. July of 1983.

Mr. KASICH. I am sorry. In July of 1983, that is when that first missile came off. So all along that assembly line, while that missile was being built, somehow the inspectors didn't do their jobs as early as a year before.

Mr. PAGE. Out of that 34 or 35 people we have in the Quality Assurance Division at Tucson, AFPRO 25 percent of those people are overhead, supervisors, secretaries, so you take those people off the top. We have certain administrative functions that we analyze looking at paper and systems. What that comes down to is out of that 35 people, 16 of them are in what we call a product verification branch. Out of that 16 people in that branch, there are 6,000 Hughes employees in the manufacturing area doing their job.

Circuit boards, for example, have literally hundreds of solder joints. One defective solder joint is a defect. One defective missile is a defect. We have our 16 people trying to stay on top of that 4,000 or 5,000 or 6,000 people building the product. It is a spot-check operation. We do not have a tollgate where every piece of hardware goes through. We have that now. We have instituted Government inspections to assure that everything will be the way it should be, but it has just been on a spot-check basis.

Hughes is spread out. Final assembly and checkout is half a mile away. At best, we do a surveillance. It is a sampling operation and the best the Government looks for in a sampling operation is an outgoing outgrow of 95 percent—so 5 percent of what we don't see will be defective. That is the way sampling is done. There are only 16 people.

Mr. NICHOLS. The time of the gentleman has expired.

Mr. Stump.

Mr. STUMP. No questions.

Mr. NICHOLS. Mr. McCloskey.

Mr. MCCLOSKEY. No questions.

Mr. NICHOLS. Mr. Kramer.

Mr. KRAMER. Could we return to the question of how you discovered this. You indicated a teardown. How did this come about? Is that a regular procedure or was there something that somebody saw that instigated it or what?

Captain BOWES. The Phoenix missile had development and production. We wanted to get the missile into the fleet as soon as possible to replace the older inventory. We started with a design, matured the design and went through testing and had a very successful development test program, recently finished the operational test program and got very high grades for performance of the missile.

Over the last 2 years, however, we had significant difficulty in producting the missile going from the development to the production phase, and the Hughes production line had been stopped several times, anytime there were problems producing things, couldn't get them to work. We had numerous problems and had stopped the line for 2 or 3 months in the November through January timeframe. Hughes had gone through some reorganizations interally, had got the production line going again. We had a production review at Hughes in February to see if we felt the corrective action taken would enable Hughes to produce according to our contract schedule.

We had high confidence that Hughes could produce the missile right and they had fixed those producibility and design problems.

After I felt confident that the missile was being produced correctly, I felt that it was now appropriate to tear it down and see what was inside. We had high confidence that the missile worked. Our testing confirmed that. The process used to build the missile used a lot of stress screening, so we had every confidence that all the sections and units in the final built-up missile worked. We wanted to make sure we were building the missile according to specifications and that over time we would not have failures, so we tore down the missile. That is when we found our problems.

Mr. KRAMER. Is this a regular technique that is employed?

Captain BOWES. Yes, it is.

Mr. KRAMER. How did the other missiles get involved then?

Colonel SLINKARD. Well, obviously the other services were aware of the results of the Navy's teardown. The Maverick missile teardown was a scheduled teardown, which, as I said earlier, was accelerated, that is brought earlier on a calendar basis, to be done in conjunction with this contractor operations reveiw. But it would have been done later had the contract operations review not occurred.

Mr. KRAMER. You said there was something the matter with the TOW also?

PROBLEMS WITH TOW

Colonel SLINKARD. Similar things were found in the TOW although not quite as bad.

Mr. KRAMER. None of the problems were discovered from a typical online inspection, is that right?

Colonel SLINKARD. There were problems discovered in typical online inspection. You know, that particular solder ball or that particular solder joint was not, but there were problems found as they went along. I can get you some documentation of that and submit it, if you like, sir.

Mr. KRAMER. But none of these proportions, this magnitude or volume?

Colonel SLINKARD. At least not this incidence and, of course, as was mentioned earlier, these were in a final product. You know, it is one thing to find something along the way at a point where it can be corrected, and it is another thing to find it in the final product as delivered.

Mr. KRAMER. Based on what has happened at this point, are you contemplating some type of investigative action to see whether or not disciplinary action is to be taken against some of these people in your activity or not?

Colonel SLINKARD. That is a question really that should be answered by their commander. I know that he has made some changes in personnel assignments. He has instituted some retraining, some additional changes in procedures, and there is a broader look being undertaken of the entire Air Force Contract Management Division and the way it does quality assurance and manufacturing to try to be sure that we don't have systematic problems in the procedures and the way we go about our business.

Mr. NICHOLS. The gentleman's time has expired.

We have a recorded vote on the floor. I am going to suggest that the committee stand in recess for 10 minutes and, when we come back, Mrs. Byron from Maryland will be next.

[Brief recess.]

Mr. NICHOLS. The subcommittee will come to order.

The Chair recognizes Mrs. Byron.

Mrs. BYRON. Thank you, Mr. Chairman.

Let me say first of all that I think all of us have read with an unfortunate feeling the newspaper articles recently on the problems with faulty workmanship. We have just finished going through a scenario with cost overruns; and now to have to face another problem area is one that I think is unfortunate to have to happen. You have testified a little bit about the scenario and the timeframe. I believe you talked about the original teardown, which was in June of this year, of a missile that was, according to your estimates, produced probably about a year ago, which would have been in June 1983.

It is my understanding that there was something that made you take the time to tear down the missile. It is my understanding that last fall, the fall of 1983, Secretary Orr had a meeting with the Hughes officials. There obviously must have been some reason why that meeting was originally called. There obviously must have been some results of that meeting, enough results that your people should have been put on notice at that time to make a better assessment as we were moving along.

We did not really close down the production line immediately. That sort of went on. It would seem in your mind, and I am sure it

has to seem in my mind, questioning what type of a production was coming off of those lines during that timeframe of when the initial missiles were produced, that there is faulty workmanship in the missiles that have been accepted.

We have seen some newspaper articles, and I think I have to paraphrase here. But a Hughes employee within the plant has said that the top management has been complacent. That isn't something new that just transpired overnight. It has been a situation that has been growing. I think there is also some question of whether it was just in the Hughes plant there in Arizona; or, are there problems in other Hughes plants?

Is it a Hughes management problems? Is is a problem just at this one plant that has the responsibility for the Maverick, the TOW and the Phoenix; or is also, as has been rumored in the press, that there have been problems with the radars also produced by Hughes at El Segundo.

Could you touch on all of the above, please?

RADAR PROBLEMS AT EL SEGUNDO

Colonel SLINKARD. I will do my best. There has been a review of the radar at El Segundo. Similar problems were found, but not to the same degree. the incidence of problems is not as great.

Mrs. BYRON. Of course, the radar we are talking about there is not as costly either, so we are talking about percentages.

Colonel SLINKARD. But the incidence of physical quality problems is not necessarily a function of cost, I don't believe. I just meant to convey that there are similar—there were similar problems found, but the number of problems was not as great and the severity of the problems was not as great. There are actions underway by Hughes to make sure, and General Skantze has told Hughes management that he expects their corrections and their changes in the way they operate not be be confined to Tucson, that those are to be carried forward to El Segundo and the ground systems division at Fullerton and wherever else such problems may exist. I want to cite that Hughes management has said that and has told us that they have had people from the other divisions in to their meetings on what they are doing at Tucson, and that Dr. Puckett and Mr. White clearly, at least in the things I have read, have said this emphasis on quality and changing the way they do quality assurance applies throughout the company, not just at Tucson.

I should also say that there is a series of product assurance integrity reviews being done at the various plants. The commander of AFCMD had all of his plant representatives in, went over what had happened at Hughes and what had been found at Hughes, and has laid out a schedule to do a series of product assurance integrity reviews, which in English means the sort of thing that Mr. Page and company did at Tucson—to go back and identify those contract requirements, trace them through and look at them in the hardware and see if those military standards and Military specs are really being complied with and show that to the contractor. So there is an effort underway to address how wide is that problem and are others the same.

We do not believe that Hughes, Tucson is representative of defense contractors generally, but we will follow the facts where they lead us.

Mrs. BYRON. Would the chairman give me 60 seconds more?

Mr. NICHOLS. Yes, without objection.

Mrs. BYRON. Thank you.

It is my understanding that you testified you have 30 people within the plant on quality control. Those are Air Force blue suiters?

QUALITY CONTROL

Colonel SLINKARD. They are mostly Department of the Air Force civilians.

Mrs. BYRON. Does the Navy have people on quality control, or does the Air Force have that responsibility?

Colonel SLINKARD. The Air Force has the in-plant quality assurance responsibility.

Mrs. BYRON. Your 30 people that you had in the plant with the responsibility on quality control at what time did they pick up that there was a problem with quality control?

Colonel SLINKARD. When they find problems in quality control——

Mrs. BYRON. I am not talking about one or two problems. We have some massive problems that have developed with the missiles when they were torn down. They obviously had to pick up some of that in their work if you have 30 people in a plant.

Colonel SLINKARD. There were 16 form 47s issued to Hughes management citing problems in quality control systems and compliance with quality control systems since October 1982.

Mrs. BYRON. I don't know how many should be issued, but doesn't 16 seem an excessive number?

Colonel SLINKARD. Yes; that is not just, I found one bad solder joint. It is more than that.

Mrs. BYRON. So since October of 1982, you have had 16 issuances of citations. Wouldn't that lead you to believe that there was a problem within that facility?

Colonel SLINKARD. Yes.

Mrs. BYRON. And yet it took until June of this year, 1984——

Colonel SLINKARD. Hughes responded to those and promised corrective action and to some degree took corrective action.

Mrs. BYRON. To your satisfaction?

Colonel SLINKARD. I didn't read the responses personally, so I can't say whether they were to my satisfaction. I was not there. I don't receive those responses myself.

Mrs. BYRON. The 30 people within the plant, are they responsible to you?

Colonel SLINKARD. No, ma'am; not directly. They are responsible—the structure is as follows——

Mrs. BYRON. They must be responsible to somebody; and whoever they are responsible to should be assured that the things are being corrected. Otherwise, what I want to know is why they were not corrected; and if the people responsible for those 30 people within

the plant were satisfied, then they are wrong; if they were not satisfied, then they should have done something about it.

Colonel SLINKARD. There is an Air Force plant representative, a commander of that plant to whom those people are responsible through his Chief of Quality Assurance. He in turn is responsible to the commander of the Air Force Contract Division——

Mrs. BYRON. Is the one on the site still there?

Colonel SLINKARD. The one on the site has been there approximately a year, perhaps less that a year.

Mrs. BYRON. But he is still there?

Colonel SLINKARD. Yes.

Mrs. BYRON. Is he one of the ones responsible for uncovering the problems?

Colonel SLINKARD. I believe that he is, yes.

Mrs. BYRON. The other question I asked you was about Secretary Orr and Mr. White and what were the results of the meeting in the fall of 1983 with the Hughes people?

Colonel SLINKARD. My understanding of the results, and that is in part what Mr. Hooper was trying to address earlier, was that that meeting was primarily related to the productivity problems that were found in a manufacturing review that Mr. Hooper described. He said that Hughes' first corrective action plan in response to those problems was not satisfactory, and that another review was done, and that ultimately after a briefing was given to the Secretary that Hughes did provide what was a satisfactory plan on the productivity problems, had submitted two quarterly reports, and had made some progress.

Mrs. BYRON. Had made some progress?

Colonel SLINKARD. Had made some progress and Charles Hooper cited that they had made some progress in their performance indexes against their labor standards. My recollection is that they had not made as much progress as we had expected in scrap and rework.

Mrs. BYRON. When they don't make as much progress as you expect, do you then go back and make sure that the progress improves to your expectations?

Colonel SLINKARD. We certainly try to lean on them, yes, and——

Mrs. BYRON. What type of a timeframe was that?

Colonel SLINKARD. Beg your pardon?

Mrs. BYRON. When was that when they reported back that they had not made as much progress as you had expected?

Colonel SLINKARD. I don't want to imply that Hughes——

Mrs. BYRON. I hope it was the Air Force that had responsibility for quality control that was making those decisions.

Colonel SLINKARD. Yes; but those plans were fundamentally on the subject of productivity, scrap, rework, work measurement standards, how much of the work was covered by standards, how many actual hours it took to do one standard hour of work.

Is that correct, Charles?

Mr. NICHOLS. Mr. Darden? Mr. Hutto? Mr. McCurdy?

Mr. Dickinson? Mr. Ray? No questions.

Mr. Battista, do you have questions?

Mr. BATTISTA. Thank you, Mr. Chairman.

Mr. Hooper, you first presented the Contract Management Division findings to Secretary Orr in February of 1983, is that correct?

Mr. HOOPER. Yes, that is correct.

Mr. BATTISTA. I think I have an accurate copy of your presentation here. You reported that in a Hughes Aircraft Corp. opinion survey, 67 percent of the workers agreed that too many employees take it easy during the work day?

Mr. HOOPER. Yes.

Mr. BATTISTA. And that 56 percent of the employees disagreed that poor performance is usually not tolerated?

Mr. HOOPER. Correct.

Mr. BATTISTA. And that 55 percent disagreed that the work flow is usually well organized?

Mr. HOOPER. Yes.

Mr. BATTISTA. That was in February of 1983?

Mr. HOOPER. Correct.

Mr. BATTISTA. What period did that cover?

Mr. HOOPER. I don't recollect exactly when the opinion survey was done. It certainly was prior to December 1982, but I don't recollect the exact dates.

Mr. BATTISTA. OK. I am looking at the original document here prepared by the Contract Management Division. And I take it that was the basis for your report to the Secretary?

Mr. HOOPER. That is correct.

Mr. BATTISTA. OK. Now, Mr. Shelhan, I believe it was, with regard to foreign military sales of Maverick, the date of this is December 1982—some of the conclusions and recommendations were that Hughes perpetuates inefficiency by hiring four to five times more people than the work content available. Are you familiar with that?

Mr. HOOPER. Yes.

Mr. BATTISTA. And that there was an extremely high percentage of rework and scrap?

Mr. HOOPER. That is correct.

Mr. BATTISTA. How would you categorize it in comparison to an industry average?

Mr. HOOPER. Hughes would be higher than the industry average.

Mr. BATTISTA. About how much higher, just a ballpark figure?

Mr. HOOPER. In December 1982, I would say from what data we have available on the industry, probably twice as high.

Mr. BATTISTA. In terms of efficiency, and I generally consider my own personal feeling of efficiency as being standard hours divided by direct hours. My calculation based on Air Force data, is that the variance at the Tucson plant is somewhere between 4 and 12 percent efficiency, which is about anywhere from 3 to 7 times less than what I would consider an industry average to be. Is that a correct assessment?

Mr. HOOPER. In the December timeframe, December 1982, which is where this data came from, we reported out efficiency by program and certainly on the IR Maverick the efficiency was in that range, the 5 to 7 percent range. It, of course, was a little higher on the more mature production programs and up to somewhere around 40 to 45 percent as I recall on the TOW, for example.

Mr. BATTISTA. On the question that Mrs. Byron asked, for example, when did you first find out about the problem, with regard to the high percentage of inefficiency and residual work force? According to this document that had occurred after 320,000 TOW missiles had been delivered.

Colonel SLINKARD. That is correct.

Mr. BATTISTA. Colonel, you had indicated that Hughes promised to do well after that. What does that mean? To do better? Did you have a modification to a contract or what actually do you mean by "Well, they said they were going to do better?"

Colonel SLINKARD. My understanding is that they put in a corrective action plan as to what they were going to do.

Mr. BATTISTA. Did you see that corrective action plan?

Colonel SLINKARD. No, sir; I was not in the job I am in now at that time.

Mr. BATTISTA. Who did see it?

Colonel SLINKARD. Do you know who all reviewed it, Charles?

Mr. HOOPER. I am not entirely sure who all reviewed it. I know that the action plan was briefed by Hughes up through channels at least as high as the commander of the Air Force Systems Command.

Mr. BATTISTA. Could we get a copy of the corrective action plan that was given to the Air Force, Mr. Chairman?

Mr. NICHOLS. Without objection, we would direct you, please, to produce a copy of that for the record.

[The following information was received for the record:]

Requested action plan is attached for the record. Please note that the plan is marked with a "Competition Sensitive" notation, which states that the information was submitted in confidence, is privileged and exempt from disclosure under the Freedom of Information Act, and is subject to 18 U.S.C. 1905.

[A copy is maintained in subcommittee files.]

Mr. NICHOLS. Mr. Battista, identify exactly what you want.

Mr. BATTISTA. The colonel indicated earlier that Hughes promised to do better and that basically took the form of a corrective action plan. Was that presented to the Chief of the Air Force or to System Command?

Mr. HOOPER. That is what I meant to clarify. As a result of the December 1982 briefing, and subsequent briefings to the Secretary, Hughes was requested to produce a corrective action plan. They produced that plan and submitted it to General Stukel and General Stukel said that plan was not totally acceptable and it was sent back.

It was December of 1983 when Hughes produced a total corrective action plan which they call their productivity plan. It is that plan that was briefed up.

Mr. NICHOLS. Is this the plan——

Mr. BATTISTA. That is the plan that we should have submitted for the record.

As a consequence of this process, payments were not withheld at that time, correct, on any system?

Mr. HOOPER. Not to my knowledge.

Mr. BATTISTA. Mr. Hooper, I believe you indicated in your presentation that the rejection rate at Hughes for the inner board, for ex-

ample, of the IR Maverick, was something like 60 percent; do you recall that figure?

Mr. HOOPER. I remember reporting the inverse of that.

Mr. BATTISTA. You had 40 percent, so I assumed that the rejection rate was 60 percent.

Mr. HOOPER. That is correct.

Mr. BATTISTA. The industry average, as I understand it right now for PC boards with that technology, is less than 5 percent, isn't it?

Mr. HOOPER. I would think that would be about right.

Mr. BATTISTA. With regard to the question Mrs. Byron asked about what did you do about the problem with 30 people there, an allegation was made that basically Air Force personnel advised the Government inspectors that it wouldn't be part of their career-development program if they red-tagged or rejected any of these missiles. Are you aware of that allegation?

Colonel SLINKARD. I have no knowledge of that, no, sir.

Mr. BATTISTA. OK.

Captain, are you aware of a similar allegation involving Navy personnel?

Captain BOWES. No, sir. I am not.

Mr. BATTISTA. Are you aware of any investigations that are presently in progress?

Captain BOWES. No, sir. I am not.

Mr. BATTISTA. Whom do you report to?

Captain BOWES. I report to the commander, Naval Air Systems Command, Admiral Busy.

Mr. BATTISTA. Mr. Page, in your presentation covering the period July 18 through August 2, system by system, your conclusions are that basically the production drawings don't match the production missiles, that in some instances there is no indication that inspections were even taking place, is that correct?

Mr. PAGE. I didn't make any comment about inspections not taking place. Based on what we saw, you would wonder how effective an inspection would be.

Mr. BATTISTA. You have a summary of findings from Maverick that there is no indication of inspection status.

Mr. PAGE. What that alludes to is in MIL-Q 9858A, there is a requirement that hardware, while in process, must maintain inspection status, either acceptable or unacceptable. The finding there was some spools of wire, raw stock, that were laying in an area without a sticker on them telling you that they were good or bad spools of wire. That is the inspection status we were talking about.

Mr. BATTISTA. OK.

Captain, how is the Navy contract for Phoenix written? For example, if a missile leaves the Hughes plant and is delivered, say, to Point Mugu, and the missile is found to be deficient at Mugu, who bears the cost of shipment back to the Hughes plant if that is warrented?

Captain BOWES. We end up having the two contracts that are in place, the contracts in place now are firm—FPI contracts; so if a missile is sent to Mugu and at that time checks out bad, it would have to go back if it is a C missile to a user's depot. That cost

would be borne by the Navy and the cost to repair would be a shared cost with the repair contract with Hughes.

We accept the missile at Hughes and, once we accept it, then it is the Navy's missile. Although we have a guarantee that 10 percent of the missiles by the time they get to the Navy Weapons Station and are tested there, that is the maximum that is allowed to fail.

Mr. BATTISTA. Ten percent are allowed to fail?

Captain BOWES. Yes.

Mr. BATTISTA. Are you familiar with a Mr. McGee at Point Mugu?

Captain BOWES. No, sir; I am not.

Mr. BATTISTA. How many missiles have failed?

Captain BOWES. Zero.

Mr. BATTISTA. No Phoenix C missiles have been returned to the Hughes plant from Point Mugu?

Captain BOWES. No Phoenix missile, after having been accepted by the Navy after delivery to Point Mugu, has failed that first test.

Mr. BATTISTA. How many have failed at Point Mugu?

Captain BOWES. During the OP-EVAL period of time, we had 10 captive carry failures.

Mr. BATTISTA. How many?

Captain BOWES. That was over a period of some 2,500 hours of time. And each one of those as part of the contract would then be sent back to Hughes.

Mr. BATTISTA. Let me ask for one more thing with the chairman's concurrence. Could you go back and find out or investigate the allegation and report back to the committee that Air Force and Navy employees were advising Government inspectors to accept these missiles regardless of the state or condition?

Captain BOWES. It is impossible to have that happen, sir.

Mr. BATTISTA. It is not impossible. I have been talking to Navy people within the past few days, so I would ask you to go back and check and provide that formally for the committee. If you think it is impossible, report that back.

Captain BOWES. I must understand the question. Since the method of acceptance is the passing of a very extensive test on a PSM 130 test set, and if all the parameters are met, then the missile is therefore accepted. There is no subjective criteria, so that is why I don't understand that kind of a statement with regard to Phoenix. We run through the PSM 130 test set.

Mr. BATTISTA. I believe you said that once a missile leaves the plant, it becomes the Navy's responsibility?

Captain BOWES. Yes.

Mr. BATTISTA. And it is an FPI contract, and if it gets to a depot or a location like Mugu and it doesn't meet the fleet requirements and it runs across a problem, you send it back. If indeed the allegation is correct that Government inspectors were advised to accept those missiles, then they would obviously get to Mugu and be shipped back at the Navy's expense and then there would be cost sharing on the corrective action, is that right?

Captain BOWES. Yes.

Mr. BATTISTA. I want you to find out if Navy personnel were advising Government inspectors to accept those missiles regardless of whether or not they work.

Captain BOWES. Yes, sir.

Mr. BATTISTA. Thank you.

Mr. NICHOLS [presiding]. Mr. Kasich, do you have any questions?

Mr. KASICH. Mr. Chairman, I don't have any questions. I just want to express my concern that I don't know whether the witness is trying to avoid—sometimes I get the distinct impression when I sit in this committee that witnesses are always trying to split hairs when they answer questions and that if you don't hit the questions right on the head, they aren't going to give you an answer, Mr. Chairman. I just hope that is not going to be a continued pattern because I think it leaves a problem with credibility, listening to these witnesses.

Mr. NICHOLS. Mr. Chase.

Mr. CHASE. Picking up on one question from Mr. Battista, is that a correction of deficiency clause in the Phoenix-C with the Navy?

NAVY'S DEFICIENCY CLAUSE

Captain BOWES. The current contract has a GLAT, meaning a Government lot accepted answer test procedure where we end up testing a random number of missiles in each lot and those are obligated to all pass. If they don't, then we have the—contractor is required to fix those that don't pass.

We don't have a standard correction of defects clause in the fiscal year 1983 and subsequent contracts. However, the current contract being negotiated will contain a standard correction of defects clause.

Mr. CHASE. Why did that contract not have a COD correction deficiency clause, this one that has a GLAT clause?

Captain BOWES. That had been the procedure we had been accepting missiles under and we now are adding warranties as per the appropriations language of last year, that that will be added to all contracts in the future. It had been the——

Mr. CHASE. Even before warranties were the vogue, there were systems that I have been familiar with that usually had a correction of deficiencies clause in the contract, that the contractor picked up the costs to repair any——

Captain BOWES. Any latent defects. We do have a latent defect clause in the contract. We do not have one if the missile doesn't perform as per the contract, we do not have a warranty for that in the current contract. However, Hughes has offered to give us and the Navy will accept, a warranty on all of the AIM 54C we have now. We are now negotiating the terms and lengths of this warranty that will cover any failure that occurs to quality of workmanship cost.

Mr. CHASE. Colonel Slinkard, Mr. Battista referred to the manufacturing management production capability review report of December 1982 that Mr. Hooper, the team Mr. Hooper led, did. In that review, in the executive summary, there was a list of recommendations that essentially tasked Air Force Systems Command to do certain things or recommended some actions, such as:

> Air Force Systems Command should require a producibility program review, should establish a joint triservice Hughes productivity incentive. Hughes should be encouraged to improve management systems.

Were those recommendations pursued formally by Air Force Systems Command and, if they were, what were the results?

Colonel SLINKARD. I don't know the answer myself, but I will find it and submit it to you, sir.

Mr. CHASE. You don't know.

Mr. Hooper, do you know the answers to those questions?

Mr. HOOPER. I believe I can answer them.

Mr. CHASE. Would you, please?

Mr. HOOPER. I hope as a result of that report and recommendations, producibility policy in the Air Force Systems Command was changed, the regulations were changed to add emphasis requiring that producibility be addressed in all new contracts.

There was a joint triservice team formed as a result of that review. We had participation from the Air Force Contract Management Division which actually conducted the review, along with representatives from each of the DOD program offices that were there, and that committee met on several occasions, performed some action items, wrote some letters to Hughes expressing concern over the findings in that activity. So, that yes, that was done.

Could you repeat the third one again?

Mr. CHASE. Hughes should be encouraged to improve management systems.

Mr. HOOPER. Yes, sir; and the encouragement took the form of letters from the commander of Air Force Systems Command, as well as letters from each of the program managers who had programs in-house at the time, and the commander of Air Force Contract Management Division.

Mr. CHASE. This is subjective, it requires a subjective judgment. Do you believe that this report contributed to improving your effort, contributed to improving the situation at Hughes?

Mr. HOOPER. Initially, I think that Hughes' initial reaction was negative. I don't think they really responded to the report until a followup effort was accomplished in August of 1983 when we reported back to the Secretary that very little progress had been made since the December meeting and I think at that time, particularly with the emphasis of the Secretary in calling in the Hughes management people, I think at that point the Hughes people did take it seriously. As a result of that, the productivity plan, which was previously asked for, was a result of that.

Mr. CHASE. Thank you, Mr. Chairman.

Mr. NICHOLS. Thank you very much.

Thank you, gentlemen. We appreciate your testimony.

The next witness for the afternoon session will be Mr. C. Blaine Shull, manager of Tucson activities, Hughes Aircraft Co. We apoligize for being so late in the day. I hope you bear with us. We want to give you your opportunity to make whatever presentation you want.

STATEMENT OF C. BLAINE SHULL, MANAGER, TUCSON ACTIVITIES, HUGHES AIRCRAFT CO.

Mr. SHULL. Thank you very much.

Mr. NICHOLS. Do you have a written statement?

Mr. SHULL. I do have a written statement and there are some copies that have been distributed.

Mr. NICHOLS. Do you want to submit it for the record, or do you want to talk from it?

Mr. SHULL. I was to talk from it and there are included by reference in this some attachments that I thought might be enlightening as I go through it.

Mr. NICHOLS. Without objection, your statement will be made a part of the official record, sir.

Mr. SHULL. Thank you.

I am Blaine Shull, recently assigned, and currently responsible for the Tucson site production activities of Hughes Aircraft Co. I appreciate the opportunity to appear before you to report on what is going on at our Tucson facility.

In case you are not familiar with our Tucson operations, let me size them for you. We occupy about 2 million square feet, supplied about equally by the Air Force and Hughes, and employ about 6,500 people. We are in production on TOW, Maverick, and Phoenix missiles as well as an Angle rate bombing system. In addition, work is underway on early models of AMRAAM. Our products are fielded by the Army, Navy, Air Force, and Marines. The first two attachments to this statement show more details of our operations down there and the products we were planning to put out.

To begin, a brief look at recent history may help put things in context. It has been reported this afternoon and you have heard elsewhere, over the past few months, several Government audits were made of the quality of hardware being produced in our Tucson plant. The reports of these examinations and resultant administrative actions taken by the cognizant Government agency overseeing our activities, caused us to look harder at ourselves. What we found, in general, confirmed findings of the Government's reviewers.

We do differ in degree regarding these findings, but debating the differences would divert energy nonproductively while we are working hard to improve. We are convinced we can, and should, do better.

We have developed, and are continuing to expand, a broad quality improvement plan. It involves fundamental changes in our management approach. Our plan directs a number of actions toward a single major goal: defect-free operations.

While we at Tucson represent only about 10 percent of Hughes Aircraft Co., we have received guidance and firm support from the corporation. Earlier this summer, our chairman and president, jointly set down a policy of "quality first" for Hughes. The policy recognizes potential priority conflicts with other objectives, but insists upon quality first in the conviction that other traditional business objectives will follow successfully. It also expresses confidence that our people want to deliver top quality products to our customers.

OBJECTIVES

This statement followed an earlier commitment to quality and productivity that adopted five specific objectives for Hughes for the decade of the eighties. They are:

One, design for producibility—make it easy to build.

Two, apply technology to the processes of designing and building high technology products.

Three, make total quality a way of life.

Four, release the full capabilities of our people.

Five, make suppliers full members of the Hughes team.

In restructuring for our quality plan, we have firmly adopted methods that break with tradition:

(A) To return responsibility for quality to each performer as distinct from a quality control department acting as a referee.

(B) To concentrate on process controls.

This focuses our attention on building good quality in rather than inspecting bad quality out. We have strengthened inspection control as an interim supplemental necessity, but intend to phase over to the former approach as soon as our demonstrated performance allows. We believe it to be the competitive way of the future.

With this direction and backing, in early August we voluntarily suspended assembly, and only assembly operations, and related inspection and test. That involved about 15 percent of the people at Tucson. Our operations continued, for the primary focus of our shortcomings was in the assembly area. Our improvement plan, however, applies to all operations within the plant.

We directed all employees whose assembly work was suspended to examine, critically, work instructions, tooling, and worker understanding and capability. Each assembly supervisor was assigned a team of manufacturing and design engineers to help in the review, and with subsequent modifications. We set down criteria for resumption of assembly operations: Each supervisor was to declare his team to be ready to restart part number by part number, confirmed by his manager and quality assurance.

We are correcting systemic problems through a redirection of management, more discipline in operations, in indepth self-examination, and an upgrade of all operations.

We have instructed our organization and the management staff. New quality policy and oversight responsibilities have been assigned within our missile systems group—the portion of Hughes to which Tucson reports. I have joined Tucson in a new position responsible for all Tucson site activities. Reporting to me is a new product quality director responsible for audit, inspection and test, and for developing the more analytical total quality approach.

We have drawn upon our space and communications group for a new manufacturing division manager who helped develop the quality practices of satellite production where success is absolutely dependent upon defect-free hardware.

Assembly people whose hardware building tasks were suspended were immediately assigned to participate in an indepth review of their operations. They reinspected their own recently produced hardware. They critiqued work instruction documents for clarity and conformance to engineering designs. Work instructions are

those documents that translate engineering drawings into terms that can be used for repetitive production operations.

Assemblers likewise determined whether they had been building hardware precisely as required by those work instructions. The magnitude of our task is large. In our plant we operate to more than 1,600 different specifications, over 10,000 engineering drawings, and over 3,600 assembly work instruction documents for more than 1,000 different subassemblies.

The results of this self-review are thousands of requests for changes in work instructions and engineering drawings. Many of these changes are record changes, that is, not subtantially affecting hardware performance or reliability, but not precisely correct. Examples are: A bracket call-out on a different drawing indenture than the indentured level at which installed; removal of a potential ambiguity as to which type of masking tape to use on a specific operation.

Some of these requests for change call for lower cost design, such as including the part number designation as an integral part of printed wiring board master artwork rather than subsequently stencilling it on. Another suggests the use of a tool that trims leads more precisely for semiautomatic component insertion into a printed wiring board.

A major conclusion of this review is the need to accelerate application of computer-controlled, graphically presented, paperless work instructions for general assembly use. With the help of Government advice and associates in Hughes and elsewhere in industry, we have raised the priority of that effort. We have also installed requirements for "prove-in" on new work instructions before their release to the production floor, and for training of the assembly engineers who prepare work instructions.

DEFECT REDUCTION PROCESS CONTROL

Another major work effort is the application of defeat reduction process controls. We have analyzed our overall manufacturing process, from buying to metal parts fabrication, to printed wiring board fabrication, to microelectronics production, to circuit card assembly, on through to missile assembly and test, and have selected a number of key control points.

We are applying defect data collection and analysis to each such point, together with specific corrective action plans and forecasted improvements. As well as being the basis for management action, these will be posted in appropriate work areas, so that those involved can plan and track their own progress. We are indebted to industry associates and some experienced Government advice on this issue also.

We have made major commitments to upgrading of facilities. A new ultra modern microelectronics facility went on line last year. We are accelerating a new extra clean circuit card assembly area for move-in by the first of November of this year. This features better lighting, simpler product flow, conductive flooring and work surfaces to prevent eletrostatic damage to sensitive semiconductor devices, and isolation of critical processes.

In addition, we have committed, and in several case already have on line, significantly upgraded assembly areas for each of our production programs. Equipment is in order for a substantial upgrade or receiving test capability to be on line starting in January of next year. About three-quarters of our assembly areas are being upgraded in the 1983-85 period. Over 40 percent of our major equipment items will be upgraded in the 1983-86 period.

We have a 5-year—1983-87—production-capital appropriation plan of about $250 million. We are on track through 1984 with $80 million already obligated. This includes a $20 million-plus investment for a 190,000 square-foot assembly plant in LaGrange, GA. Contracts for that plant are being let right now.

Training and learning is another area of major attention. We are recertifying our solder certification school and instructors. Content has been added to classes for operators and inspectors. We are adding our own self-certification classes for electromechanical assembly and special process equipment operators. Our expanded school facility, by a factor of almost four, is ready and expected to be filled with students within another week.

One of our noted deficiencies was in the effectiveness of independent audits. We now have an audit system which will maintain the review and reporting on which we have been concentrating for the past month and a half. Four different organizations divide the auditing of operating systems compliance, corrective action effectiveness, hardware quality, workmanship, manufacturing floor disciplines, working instructions, hardware disassembly, and contract requirements flow-down. These audit reports will also go to management for necessary corrective action.

We are updating our entire series of management, engineering, and operating procedures. Part of the update is to reflect a major reorganization made near the beginning of this year. All told, over 400 procedures are involved. They are in work with completion dates ranging from this month through December of this year. That large effort was started early in the year.

Even though moving toward built-in quality as our predominant approach, we recognize the need for assured inspection effectiveness. Suspension of assembly operations allowed self-inspection, and increased awareness of hardware quality by operators. Since judgment is often involved in the inspection process, our inspection supervisors are now reinspecting a sample, weekly, of each of their inspectors's outputs. Hardware audits mentioned above will provide a regular added insight. We will correlate our inspection results with subsequent special Government inspections.

Our long-term quality improvements will result from giving each performer at each level in each function the opportunity and the requirement to be responsible for the quality of his or her output. Each employee has "stop" authority if he or she sees something thought to be wrong or is uncertain of his or her own work.

We have adopted the "fix the problem, not the blame" concept that focuses on causes of problems rather than punishment of a participant. A key audit manufacturing floor disciplines is first of all a self-audit. Corrective action responsibility and authority for defect reduction now rests with the performing line organization.

We are pointing toward personal responsibility even within the large and complex organization.

Suppliers play a very large role with, and for, Hughes. For Tucson operations, we use 150 key suppliers, and over 4,000 nationwide. We are adding a requirements document "flowdown" control similar to our in-house instruction control.

We have sponsored, and will provide more focus to, supplier conferences for effective feedback and corrective action. We will pass along our own defect reduction process experience to selected key suppliers and will expect them to participate in a similar fashion. Our upgraded receiving test capabilities will supplement an improved corporate-wide supplier rating system. We are minimizing reliance on source inspection at our suppliers' plants by beefed up in-house test and physical analysis laboratory capability.

Our plan for restarting the hardware frozen in place when we suspended assembly operations has three tracks. The first is formally to reinspect and rework if feasible. The second track is to perform each subsequent assembly operation to new upgraded processes. The third track is to assemble to new improved processes.

Track one is now underway in almost all areas. Track two is starting in a few areas. Track three will start in our new circuit card assembly area in November and continue forever as new processes are added throughout the plant.

It is proper to recognize Government and industry organizations who have freely and openly given us support and assistance: Bendix Oceanics Division of the Allied Corp.; Underseas Systems Division, Honeywell; The Equipment Group, Texas Instruments, Inc.; The Air Force Systems Command and its Contract Management Division; Army Materiel Command and its Missile Command; Headquarters Naval Material Command; Naval Air Systems Command; and Resident Air Force Plant Representative at Tucson.

We thank them publicly. We expect to continue to work with them as our efforts mature and change.

Another important feature of our plan involves coupling our quality upgrade findings in the design engineering activity. One of our new defect reduction process control points specifically analyzes engineering changes with the goal of attacking the cause of errors the changes may be addressing. We are adding design process monitoring to assure detailed conformance to program requirements.

We recognize the need to track progress as it is being made. While we have identified about 800 specific milestones to be met over the next 6 months, we have also grouped activities into eight key categories that can be validated by observation or sampling. These categories include the areas discussed earlier.

Our plan is extensive, but it is also dynamic. It continued to develop. With involvement of Government and industry people who have helped to date, we are expanding and focusing several additional areas. These include employee motivation, expanded quality control of suppliers, clearer prioritization of capital commitments, and a management information system that distills the myriad of details involved.

LESSONS LEARNED

Finally a word about a fundamental lesson we have learned. We turned to all of our employees in a moment of need and received a fantastic response. Their ideas have been very, very helpful. They feel good about the new priority given to quality. They now "own" part of our challenge. We mean to protect that trust. We have started to release the full capabilities of our people, as directed by our corporate plan of a year ago.

I am proud of the way our people are responding. They are anxious to get rolling again and to show how well we can do. I have confidence in them.

One may wonder what took us so long to get turned on. We did have some early alerts, but were paying primary attention to two classic indicators:

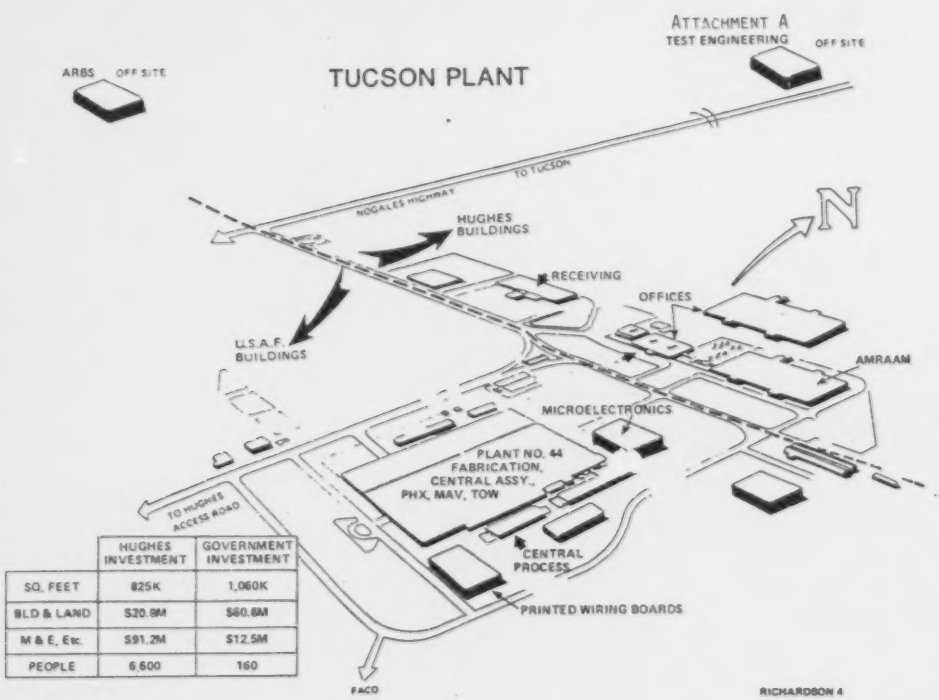
One, our production products were reported to work very, very well in the field; and

Two, manufacturing was classically measured by meeting production schedules. We now realize that each of these is best addressed through a fundamentally sound quality effort. We are learning to put quality first.

The pain of our current situation is clearly shared by our customers and Hughes. Likewise, the future benefits will be shared: Improved quality, lowered cost and improved readiness for the Government; lowered cost, restored confidence and an improved competitive posture for Hughes.

This concludes my statement. I will be happy to expand on any portion or to respond to any questions.

[The following information was received for the record:]



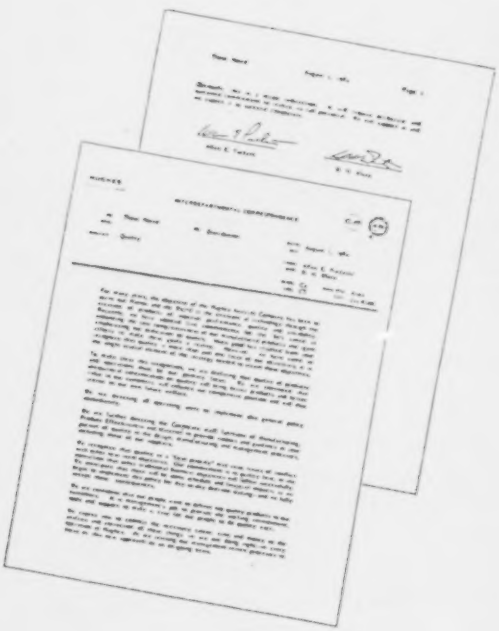
	HUGHES INVESTMENT	GOVERNMENT INVESTMENT
SQ. FEET	825K	1,060K
BLD & LAND	$20.9M	$60.6M
M & E, Etc.	$91.2M	$12.5M
PEOPLE	6,600	160

ATTACHMENT B

PRODUCT RESPONSIBILITY

HUGHES

PROGRAM PLANS	NUMBER OF SYSTEMS	
	1984	1985
TOW FAMILY (BASIC, IMPROVED, TOW-2)	29,446	26,412
MAVERICK FAMILY (IR, TV, LASER, NAVY, GBU-15)	673	1,152
PHOENIX	120	261
ANGLE RATE BOMBING SYSTEM (A-4M, AV-8B)	88	91
AMRAAM	10	93
CLASSIFIED	———	———



ATTACHMENT C

HUGHES AIRCRAFT COMPANY

COMMITMENT TO QUALITY

ATTACHMENT D

IMPROVEMENT PLAN TARGETS

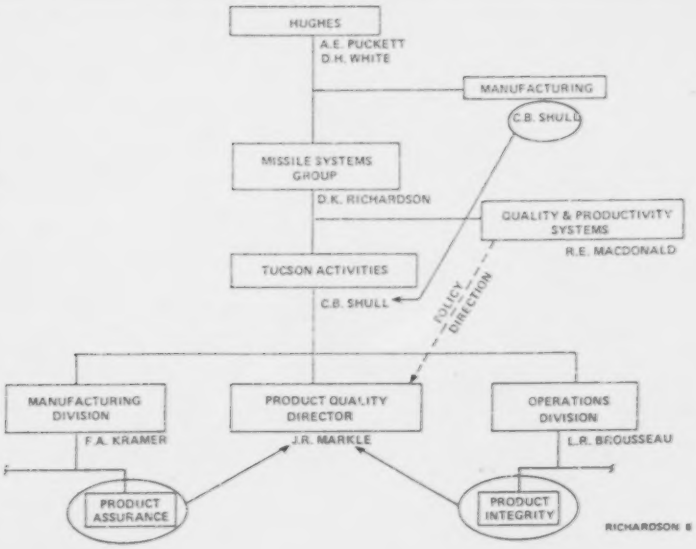
HUGHES AIRCRAFT COMPANY

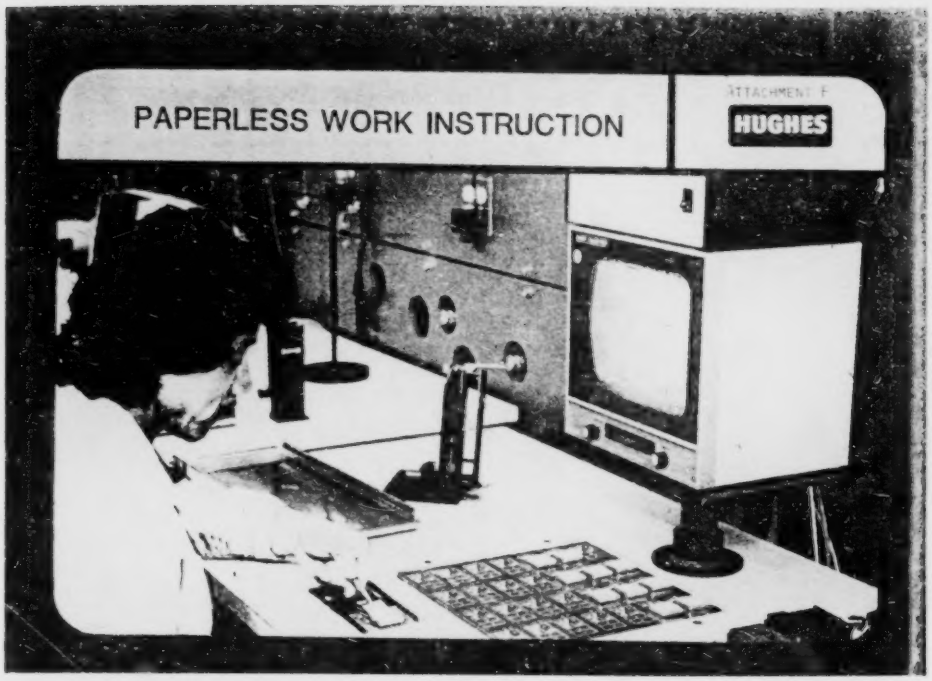
PLAN FEATURES	BUILT-IN QUALITY	INSPECTION CONTROL	PLAN FEATURES	BUILT-IN QUALITY	INSPECTION CONTROL
PROCESS CONTROL	√	√	WORK INSTRUCTION UPGRADE	√	√
DEFECT DATA ANALYSIS	√		AUDIT/FEEDBACK SYSTEMS	√	√
GOAL SETTING	√		SUPPLIER QUALITY	√	√
RESOURCE COMMITMENT	√		MFG. AREA DISCIPLINES	√	√
PERFORMERS' QUALITY RESP/AWARENESS	√	√	CLARIFIED OPERATING SYSTEMS & PRACTICES	√	√
FACILS & EQUIP IMPROVEMENTS	√		QUALITY SYSTEM EFFECTIVENESS		√
TRAINING & CERTIFICATION	√				
PROCESS STANDARIZATION	√				
DESIGN PRACTICES & DISCIPLINES	√				
ASSEMBLY SUSPENSION & ANALYSIS	√	√			
INSTITUTIONAL CHANGES	√	√			

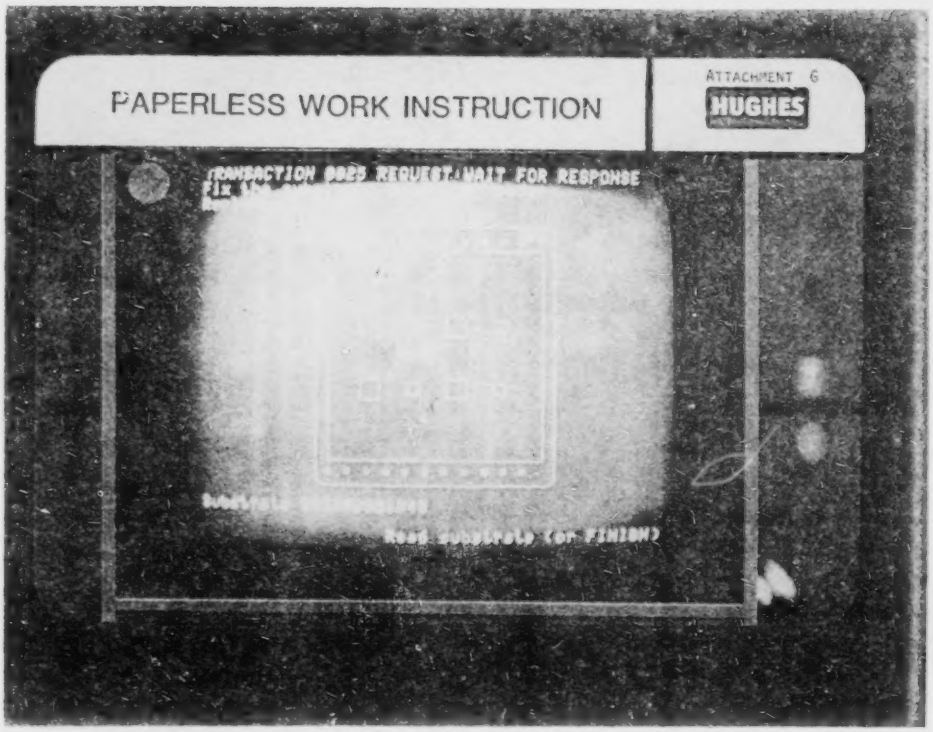
ATTACHMENT E

ORGANIZATION AND STAFFING

HUGHES AIRCRAFT COMPANY



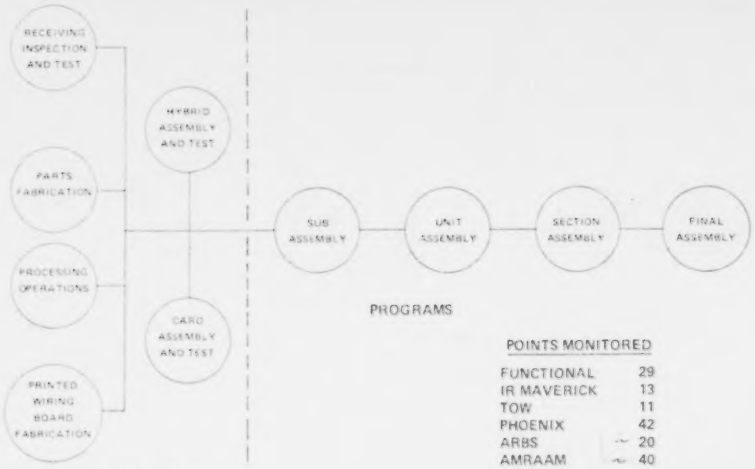

PAPERLESS WORK INSTRUCTION
ATTACHMENT F
HUGHES


PAPERLESS WORK INSTRUCTION
ATTACHMENT 6
HUGHES

PROCESS CONTROL DEFECT REDUCTION

ATTACHMENT H

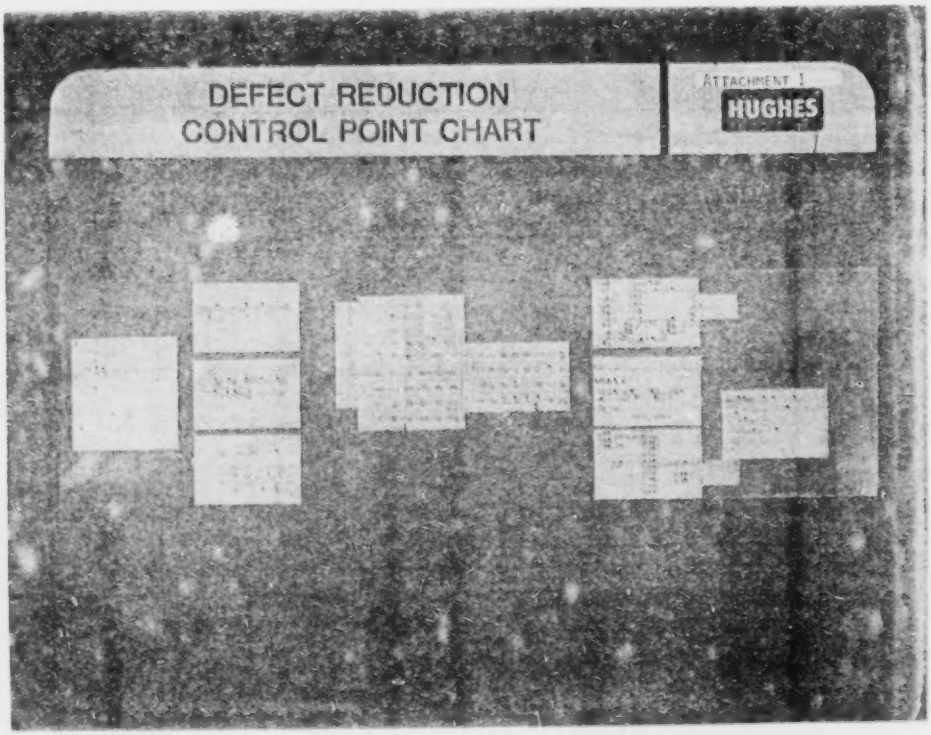
HUGHES AIRCRAFT COMPANY



POINTS MONITORED

FUNCTIONAL	29
IR MAVERICK	13
TOW	11
PHOENIX	42
ARBS	~ 20
AMRAAM	~ 40

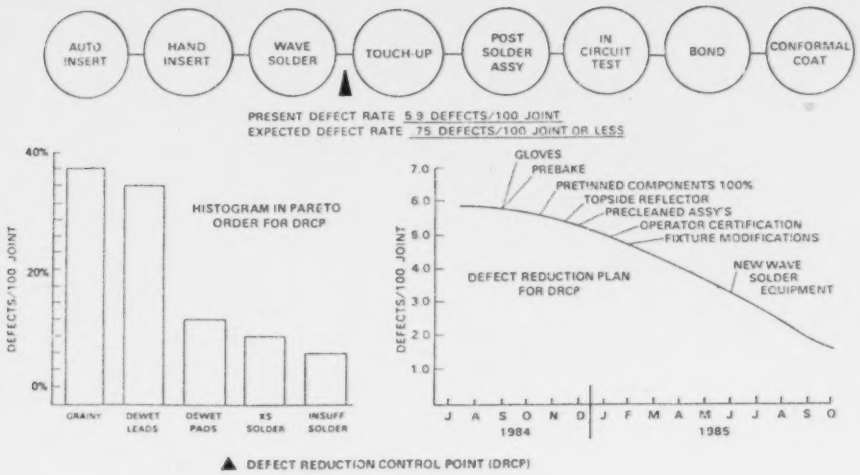
RICHARDSON 17



ATTACHMENT J

HUGHES AIRCRAFT COMPANY

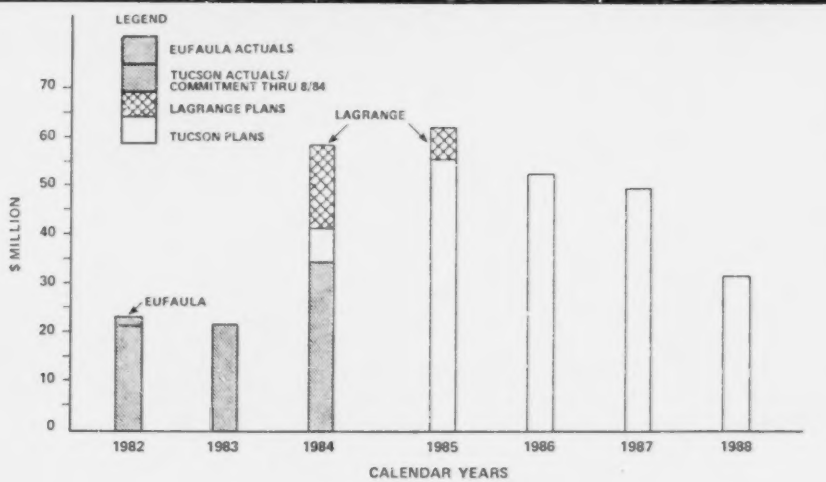
WAVE SOLDER DEFECT REDUCTION



ATTACHMENT K

HUGHES AIRCRAFT COMPANY

CAPITAL INVESTMENT FOR PRODUCTION



RICHARDSON S

FACILITY/EQUIPMENT UPGRADE

ATTACHMENT L

HUGHES

- MICROELECTRONICS – ON LINE 1983
- CIRCUIT CARD ASSEMBLY AREA – ON LINE NOV, 1984
- OTHER COMMITMENTS

	ON LINE	
	PARTIAL	FULL
MAVERICK ASSEMBLY	JUL 83	FEB 85
AMRAAM ASSEMBLY	AUG 84	DEC 84
CENTRAL PROCESSING	NOV 84	JULY 85
ARBS ASSEMBLY	JAN 85	APRIL 85
TOW ASSEMBLY	MAR 85	JULY 85
PHOENIX ASSEMBLY	JULY 85	SEPT 85
RECEIVING TEST	JAN 85	AUG 85

Mr. RAY. Thank you, Mr. Shull.

The chairman had to go to the conference committee. You have to deal with me for a little while here.

I listened to your comments with a lot of interest, and the photographs which we saw up here. I think almost every one of them indicated something that was just sloppy workmanship, which probably could have been pinpointed or caught or stopped by a good, strong, alert supervisor.

It would appear to me this is the main problem that has occurred from what we saw in the photographs. I know you have made a long statement here and identified a lot of things, but is there one major thing that you could put your finger on that might have caused the problem that began some time ago and continued? Are there a variety of things, or is there one thing? Could it be supervision or lack of management?

Mr. SHULL. It would be nice if there were a single fix that we could install. I believe that many things come to focus upon the supervisor and a number of these things we have cited in here make his job easy or tough. So that had we had really experienced top-drawer supervisors, each of whom understood we first wanted quality, some of these things might have been avoided.

I suspect over the years we translated a message to the supervision that said, we have some committed goals to make and those goals are to meet our production schedule and comply with our contracts as we said we would, so that even though our words may have said be careful, the whole cumulative action and atmosphere in the factory says meet the schedule. I think that is probably the case. If I had to single out one item, that would be the one I would single out.

Mr. RAY. How long does it take to assemble, we will say a Maverick missile, from the beginning of the assembly to the end? Is it 6 weeks, or days, or hours or how long does that take?

Mr. SHULL. I don't understand.

Mr. RAY. How long a period of time does it take to assemble one missile like the Maverick?

Mr. SHULL. Typically, if the time the first part starts into assembly until it reaches final assembly will be on the order of 6 months.

Mr. RAY. So that actually you are in the process of putting that together for half a year?

Mr. SHULL. Yes, sir; that is when everything works as it should.

Mr. RAY. Then the final step is that someone signs off on it?

Mr. SHULL. Yes, sir.

Mr. RAY. That it has been where some of the breakdown has been, I suppose, right there?

Mr. SHULL. Well, if we go back and look, if you examine those pictures, some of the breakdown as shown by the pictures may well have been in the first months of that 6 months' work, not just at the end. It could be all along.

Mr. RAY. What about the inventories that are in storage now with the military, are you going to do anything about that? Are we going to reexamine those? Have you made any moves to——

Mr. SHULL. Now, when you speak of inventories, you mean those that have been shipped——

Mr. RAY. Shipped and delivered to the Navy and Air Force and Army and so forth.

Mr. SHULL. I must tell you first that I come here as a manufacturing guy who is trying to run the plant down there, but I will also observe that we have no evidence of bad hardware in the field. As a matter of fact, our understanding is that our products classically and typically work as well, as effectively as expected or predicted by the contract or better. So that we do not see, now, evidence that says there is a big problem.

Mr. RAY. But there are some doubts. I think a question was raised here by members about the doubts that the military might have about some that are now in storage. I wondered if there would be someone who might want to just be sure to remove those doubts?

Mr. SHULL. Well, we work with each of the individual program offices and each of the programs has its own differences and applications and we will work those with them. Again, we do not see evidence of difficulties, but if we have obligations under our contracts and programs, you can be sure we will fulfill them.

Mr. RAY. The first missile was torn down in June and I think problems were found right then. It would lead us to believe that there is some problem in the inventory somewhere.

Mr. Fleshman.

Mr. FLESHMAN. I have one question. It does not relate directly to Mr. Shull's testimony. You may answer or someone else may respond.

One of the Arizona newspapers reported that in most cases Hughes itself writes the contract changes into the contract. Can you respond to that statement?

Mr. SHULL. There are perhaps three or four issues in that question. The newspaper reports, the Tucson newspaper reports I rarely take as gospel.

It is classic, however, in the business, in the contracting business, to submit a change, in which case we prepare something. It would be an engineering change proposal, an ECP that would go to our contracting agency, then they determine how they will deal with it. So it is expected that we will submit changes where we think they make sense. Their acceptance or rejection is up to the contracting agency. If the implication is that we have such neat control that we restructure our contracts for our great convenience. I think that it is without basis.

Mr. FLESHMAN. Thank you.

Mr. RAY. Mr. Lally.

Mr. LALLY. Thank you, Mr. Chairman.

Mr. Shull, you indicated that your objectives were more geared to meeting the production schedules and you may have lost sight of quality control; but the briefing sheet of Colonel Slinkard indicates, at least on the Phoenix contracts, that you are quite far behind on the production schedules, 11 months on the fiscal year 1981–82 production buy and 3 months on the fiscal year 1983 buy. Is that correct?

Mr. SHULL. That is correct, and I would point out, that if anything, that lightens the drive within a factory to meet a production schedule if we are behind schedule.

Those happened to be new development programs with startup, technical startup difficulties. When it comes down to the factory, and we have a contractual commitment to make, the impact and the pressure of meeting schedules is heightened rather than lessened because of that.

Mr. LALLY. Another question.

Mr. Page, I believe, testified that the AFPRO has roughly 30 people in quality assurance responsibilities in the plant there. Does Hughes have any quality assurance people similar to the AFPRO people?

Mr. SHULL. We have our own inspectors. We are expected to do our own inspections and testing activity and we have in the neighborhood of 250 inspectors.

Mr. LALLY. 250 inspectors. What about the workmanship such as that shown in the photographs of Mr. Page, should it have been found by your supervisors, your inspectors?

Mr. SHULL. In many of those cases, yes.

Mr. LALLY. And is there any explanation as to why it was not?

Mr. SHULL. None that I can explain, because I don't know the specifics other than what we are trying to address here, which says that we had a breakdown of the discipline that we wanted on the floor.

Mr. LALLY. And to pursue Mr. Ray's question, since the first missile torn down demonstrated workmanship of this quality, what reason is there to believe that the items already delivered do not contain the same type of workmanship?

Mr. SHULL. Well, I can't positively assure you that they have not. I would remind you that even that first missile torn down, as I believe Captain Bowes said, had been subjected to extreme environ-

mental conditioning and performed all of the functions that it was supposed to perform under those conditions. So even with the questionable items in it, it was functioning entirely properly, and that may lead you to believe that there is a margin for workmanship as to what will and will not work in the field, and I am not trying to lead and play on that margin. But once again, even if there are incidents like that in the products we have shipped, we do not have evidence of that, nor of field failures because of it.

The issue has been raised about what happens over a period of time and that certainly is an issue. You may be aware that the Army pulls TOW missiles out of their inventory that are 10, or I think they may be up to 15 or 16 years old now, and fires them regularly to see how they are aging and they still have a very high success ratio in those.

Mr. LALLY. I was impressed by another point that Mr. Page made. He said that, I believe, it was three or four of his team members who were formerly associated with the AFPRO at Hughes, and they were amazed at the difference in the quality control at this time according to their prior experiences.

What could possibly have accounted for that change in attitude of quality control?

Mr. SHULL. Well, I have to say first that I understand that to be an observation of a change. I cannot confirm that change myself because I was not closely associated with it then or now. If I were to speculate on what could have caused it, it could have been the pressures I described before and the breakdown or the reduction of the floor discipline that we wanted and are moving to reachieve.

Mr. LALLY. Have there been any changes in corporate thinking insofar as quality control was concerned?

Mr. SHULL. Quite obviously. The major commitments that have come from the corporate level, Dr. Puckett, our chairman and Mr. White, our president, and the commitment that they have made starting a year ago, and this year declaring in a very strong statement—one of these exhibits here—that says quality is first and when other issues, the other business issues of schedule and cost get in the way, quality is coming first.

I can tell you that they took that position because they believe that when we can get our arms around quality the others will take care of themselves.

Mr. LALLY. That position was adopted when?

Mr. SHULL. That was formally enunciated in the first of August of this year.

Mr. LALLY. Thank you, Mr. Chairman.

Mr. RAY. Thank you.

Just for the record now, do I understand that we do have military inspectors, DOD inspectors there in the plant inspecting these missiles, and they are constructed step by step along with your inspectors?

Mr. SHULL. They are not military, they are Government inspectors.

Mr. RAY. Federal people?

Mr. SHULL. Yes, sir.

Mr. RAY. So the statement that was made, I think in my opening statement by the Deputy Chief of Naval Materiel Command, the

Department of Defense is as much to blame as the contractor, is a correct statement, simply because we do have Federal people on the job.

Mr. SHULL. That is true.

Mr. RAY. Well, gentlemen, we offer our apologies for keeping you so long and for having so much activity today that we didn't have as large a group on the committee as we normally would have had. Many of our subcommittee chairmen are tied up in this conference item that is beginning to take place right now.

We do thank you for coming. We appreciate the fact that you have given us forthright testimony here, and we hope that we can resolve all of this in a reasonable way to the best advantage of everybody.

Thank you very much.

[Whereupon, at 4:35 p.m., the subcommittees were adjourned.]

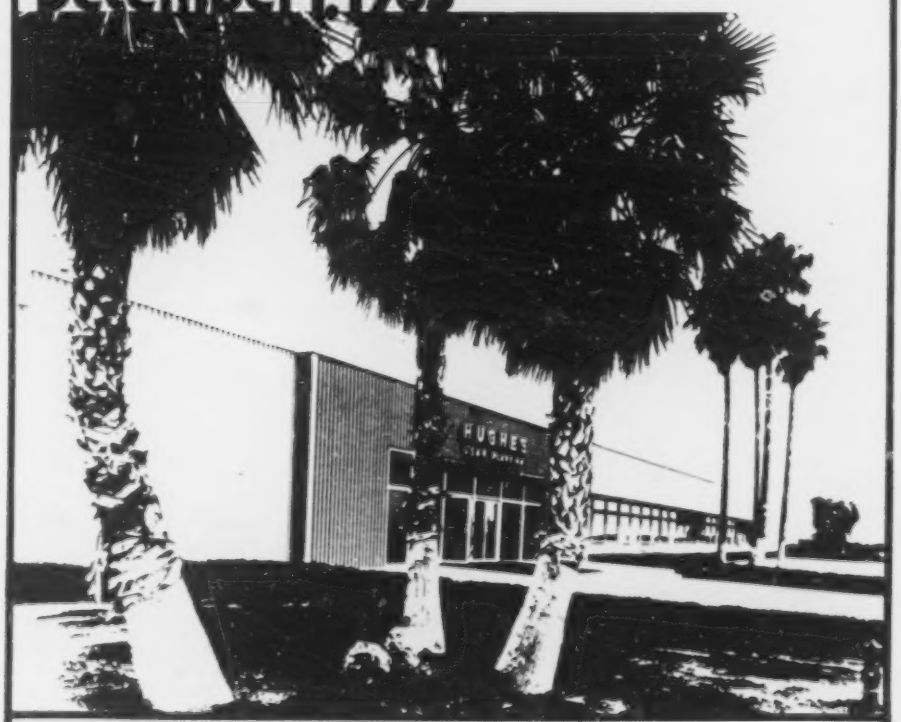
APPENDIX

HUGHES

HUGHES AIRCRAFT COMPANY
MISSILE SYSTEMS GROUP

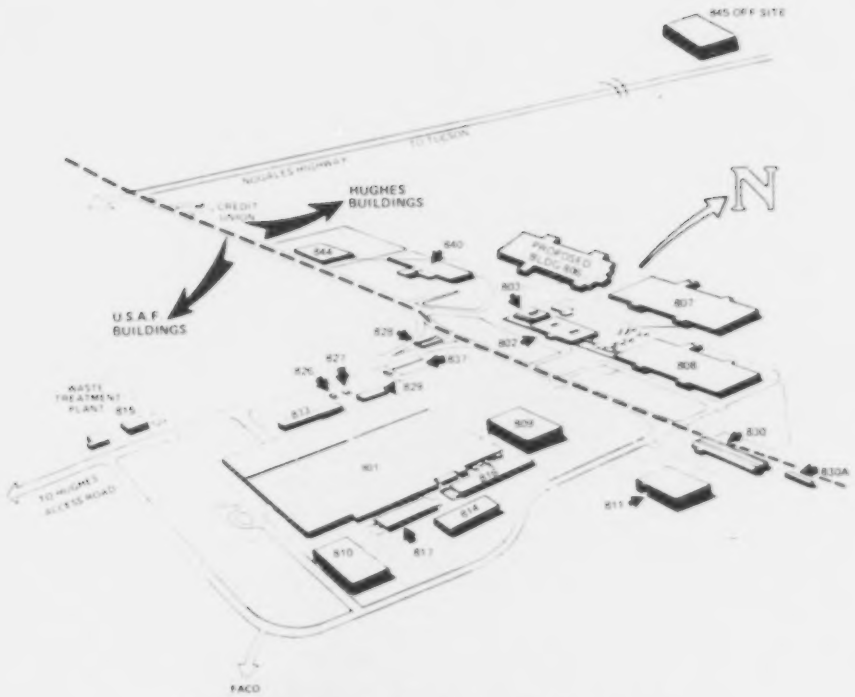
U.S. AIR FORCE PLANT 44 PRODUCTIVITY PLAN

December 1, 1983



COMPETITION SENSITIVE

Information contained herein is competition sensitive to Hughes Aircraft Company, is submitted in confidence and is privileged and exempt from disclosure by the U.S. Government under paragraph (b) of the Freedom of Information Act (5) USC 552 and subject to 18 USC 1905.



HUGHES MISSILE SYSTEMS GROUP
MANUFACTURING FACILITY
AND U.S. AIR FORCE PLANT 44

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1.0 INTRODUCTION

This document describes the Hughes Aircraft Company's Missile Systems Group productivity plans for the manufacturing activities which take place at U.S. Air Force Plant 44 located in Tucson, Arizona.

This plan is written and submitted in response to concerns reported in the Integrated Manufacturing Management/Production Capacity Review (IMM/PCR) dated November, 1982. Although many corrective actions were taken between December, 1982 and October, 1983, this plan describes actions that will take place after October 1, 1983. Progress will be reported quarterly by a detail status report, the first of which is being submitted with this plan.

Each major section of this plan begins with a brief description, followed by a detailed calendarized milestone chart, in-turn followed by a narrative describing the individual elements identified in the chart. The narrative section will also describe planned pertinent actions and expectations.

The Missile Systems Group has made full time appointments of two senior manufacturing managers to develop this plan. They have been authorized access to needed resources within the company and have guidance, counsel and influence available to them from Division, Group, and Corporate management. In addition to the available internal Hughes resources, the Missile Systems Group has employed four nationally recognized industrial engineering consulting firms. These firms, whose responsibilities are described in the body of this plan, are Booz-Allen & Hamilton, Inc., GCA Corporation, Lester B. Knight and Associates, Inc., and Rath-Strong, Inc.

The following paragraphs provide a succinct description of the technical credentials of each of these consultant firms.

Booz-Allen & Hamilton, Inc: Since 1914, Booz-Allen & Hamilton has served commercial, industrial, institutional and government clients in more than 70 countries, including 40 governments, more than 400 of the 500 largest

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1.0 INTRODUCTION (Continued)

corporations in the United States and 75 of the 200 largest companies in Europe, Latin America, the Middle East and Japan.

Booz-Allen & Hamilton is a service firm that offers a combination of general and special skills in management and technology consulting. A major area of expertise involves Manufacturing Productivity, with specific capabilities in labor utilization surveys.

GCA Corporation: GCA has Industrial Productivity Improvement (IPI)/Industrial Management Incentive Program (IMIP) experience extending back to the initial formulation of these concepts.

Mr. D. E. Wisnosky and Dr. D. L. Shunk, key management members of GCA, were part of the four-man AFML/F-16 SPO Task Force that formulated the concept and successfully structured the first working relationship. Using ICAM methodologies as the technical foundation for all IPI, these approaches have become the industry standard.

Members of the GCA team have participated in many technology modernization efforts using techniques espoused by IPI/IMIP and techniques uniquely developed for the production environment. They have been involved in all phases of technology development, from designing $IDEF_0$, $IDEF_1$, and $IDEF_2$; through contracting, monitoring and guiding development activities.

GCA team members have successfully installed and supported Tech Mod projects for companies such as Rockwell International, International Harvester, McDonnell-Douglas, TRW, Emerson Electric, Hughes Aircraft, and Martin Marietta.

Lester B. Knight and Associates, Inc: Knight is an international management consulting and engineering firm with more than 38 years of experience in the

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1.0 INTRODUCTION (Continued)

fields of industrial engineering, facilities planning, productivity improvement, maintenance, materials management and physical distribution services. The firm has more than 800 professional employees and has performed more than 18,000 assignments in 53 countries. Knight operates five domestic offices and 21 foreign offices located throughout Europe, Scandinavia and the Middle East.

Since its founding in 1945, Knight has been involved in the performance of industrial engineering assignments, the majority of which included work measurement applications. Recent Knight work measurement clients have included the U.S. Postal Service, USAF Logistics command, the U.S. Navy, the U.S. Army, and many private industrial companies.

Rath-Strong, Inc: Rath-Strong, Inc. is a management consulting firm serving business and institutions since 1935. Their expertise falls into areas of product productivity, management controls, and strategic planning. Rath-Strong has expertise in a wide range of areas but has specific talents helpful to the development of a more productive system in Hughes Tucson. These areas are in labor work measurement and printed wiring board manufacturing. Rath-Strong has served many of the large U.S. companies, local/state/federal governments, and each of the military branches.

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2.0 EXECUTIVE SUMMARY

This section describes the major elements of the Hughes Air Force Plant 44 Productivity Plan. Figure 2.1 is an overall calendarized milestone chart which summarizes the detail plans found in sections 3.0 through 8.0. The goal of this program is to improve manufacturing productivity and physical resource utilization through sound management practices and industrial modernization.

2.1 Labor Productivity Summary. (See section 3.0 for details)

The short and long range plans to improve labor performance within the manufacturing activity involve: 1) Immediate program productivity actions for the most populated manufacturing activities, 2) Short range program productivity actions for all other areas in the plant, 3) The establishment of a Labor Utilization (idle time) survey system to measure real labor performance improvement and to identify areas requiring corrective action, and 4) Immediate personnel actions to curtail idle time and to improve productivity.

The following paragraphs summarize each of these activities.

2.1.1 Immediate Program Productivity Actions.

These actions will be immediately instituted in the Phoenix assembly area, the T.V. Maverick assembly area, and the TOW assembly area to obtain rapid productivity improvements in manufacturing labor performance. These areas are selected because they provide the most opportunity for significant productivity improvements since each involves assembly disciplines which tend to run higher performance indices than those of other manufacturing areas and are staffed with a large portion of the manufacturing labor population. The action for this effort is summarized by the following sequence:

- Performance of productivity audits to establish a realistic time for an operator to perform each operation when work is available.
- A resource assessment (material and equipment availability) will be conducted to determine how much real work can be performed.

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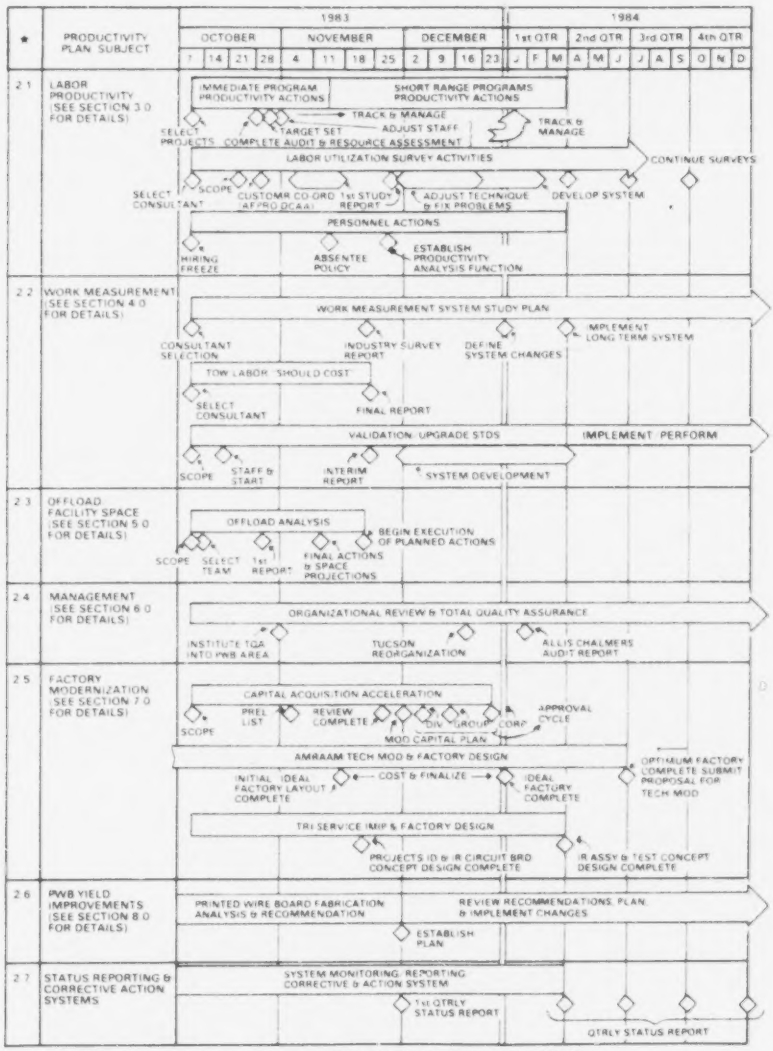

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FIGURE 2.1 PRODUCTIVITY PLAN MASTER SCHEDULE

2.0 EXECUTIVE SUMMARY (Continued)

2.1.1 Immediate Program Productivity Actions (Continued)

- o Performance goals will be set with each supervisor based on the data from the productivity audits, resource assessments, and supervisors assessment.
- o Immediately adjust staff in accordance with the goal.
- o Monitor progress, holding supervisors accountable for progress.

2.1.1 Immediate Program Productivity Actions (Continued)

These immediate program productivity actions will provide rapid productivity improvements. The results of these actions will be reported in the first Quarterly Status Report.

2.1.2 Short Term Program Productivity Actions. The actions will be similar to those described in 2.1.2 except applied to the fabrication shops, all the test areas, the hybrid assembly area, and to the process shops. The schedule shown in Figure 2.1 depicts the plan for this task and section 3.0 provides more detail about this plan.

2.1.3 Labor Utilization Survey. The plan is to conduct a labor utilization survey that will result in idle time data similar to that reported by the government audit (DCAA) originally conducted in early 1981, with a follow-up review in February, 1983. The idle time statistics obtained during that period will represent the base for improvement comparison. These labor utilization surveys will be initially performed by the outside management consulting firm of Booz-Allen & Hamilton, Inc. These surveys will be continually conducted on a routine basis with Hughes industrial engineers. Booz-Allen & Hamilton, Inc. will develop the system, perform the first three audits, recommend productivity improvement ideas, and train the Hughes team to continue the audits.

2.1.4 Immediate Personnel Actions. An interim hiring freeze will be instituted immediately. To provide for more accurate staffing capability, a productivity analysis function will be established within the industrial engineering group

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2.0 EXECUTIVE SUMMARY (Continued)

2.1.4 Immediate Personnel Actions (Continued)

that will maintain constant surveillance on workload visibility, track labor performance, and labor manpower projections. This data will be supplied to project management, functional department management, and manufacturing division management so that staffing is commensurate with work availability and schedules. In conjunction with the productivity analysis function, improved systems will be developed that will provide instant and projected visibility of available workload.

A new policy will be developed and established that will help area supervision control absenteeism from the job and the work area. This new absenteeism policy will take the form of two directives: 1) an "absent from work" point system is to be applied that will make a more rigid and consistent policy for allowable absences and disciplinary actions for excessive absences, and 2) a policy that requires employees to get supervisory permission to leave their work area and confirm their return at times other than official breaks and lunch.

2.2 Work Measurement Summary. (See section 4.0 for details)

There are three basic thrusts in this part of the plan: analysis/revision of the work measurement system, a TOW labor "should cost" analysis, and validation/upgrade of standards. Each area is summarized below:

2.2.1 Work Measurement System Study. The plan is to conduct a detailed analysis of our current system and to modify or alter it so that it provides more meaningful management tools to maintain high productivity and is more representive of the industry standard. There are several tasks that will be conducted to provide the necessary data to allow for the proper results: 1) survey the industry, and 2) segregate the contents of the standards and the "actuals" to reveal those elements that require management visibility (such as operator performance, machine details, rework, test failures, and so on). Once the system changes are initially defined, an analysis of its application will be

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2.0 EXECUTIVE SUMMARY (Continued)

2.2.1 Work Measurement System Study (Continued)

performed and its compatibility to MIL-STD-1567A will be established. The industry survey and analysis will be performed independently by two of the outside consultants, Lester B. Knight and Associates, Inc. and Rath-Strong, Inc.

2.2.2 TOW Labor "Should Cost" Analysis. Independent of the existing or planned work measurement systems, a labor "should cost" analysis is planned to establish a bench mark for good productivity. The TOW program will be used for this labor cost analysis since it is the most stable and mature production program. The consulting firm of Rath-Strong, Inc. will perform this TOW labor "should cost" macro analysis.

2.2.3 Validation/Upgrade of Standards. A team of Hughes industrial engineers will be assigned to this task with the charter to upgrade type II standards to type I standards and to validate a sample of existing type I Standards. This team will be made up of experienced industrial engineers from each of the prime manufacturing divisions of the Hughes Aircraft Company to supplement the Tucson staff. To assure an adequate and meaningful effort in this task, an outside industrial engineering consultant firm, Lester B. Knight and Associates, Inc., will overview Hughes teams' efforts with the intent of providing guidance, a credibility assessment, and a MIL-STD-1567A compatibility analysis.

The longer-term plan involves the development, implementation and performance of a system that will continue the standards upgrade/validation process on an on-going basis compatible to the contractual requirements of each program.

2.3 Offload/Facility Space Summary. (See section 5.0 for details)

A detailed review of the manufacturing offload/Make or Buy decisions, and relocation of administrative functions will be made with the intent of offloading work that will reduce the amount of space required without

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2.0 EXECUTIVE SUMMARY (Continued)

2.3 Offload/Facility Space Summary. (Continued)

adversely affecting cost. The calendarized plan shown in Figure 2.1 depicts the major milestones. A team of key management personnel taken from each of the individual program and functional manufacturing groups and chaired by a materiel manager will perform the analysis.

A second part of this effort will be to describe the space requirements with the Productivity Plan implemented versus the requirements published in August, 1983. The goal is to eliminate the need for more government-funded space.

2.4 Management. (See section 6.0 for details)

The plan is to analyze the existing Tucson management function to improve the physical structure and make attitude adjustments to more adequately address productivity. The organizational structure will be reviewed by Corporate Group and Division Management. The second aspect of management function will be covered by the continued use of the corporate-wide Total Quality Assurance System.

2.5 Factory Modernization Summary. (See section 7.0 for details)

There are two elements to this part of the Productivity Plan: 1) acceleration of capital equipment procurement that would provide for significant productivity improvements, and 2) merging the Hughes factory modernization program with the government's Technology Modernization (Tech Mod) projects and Industrial Modernization Incentive Programs (IMIP).

2.5.1 Accelerated Procurement of Capital Equipment. Manufacturing engineering disciplines from fabrication, assembly, test and inspection will review the existing five-year capital forecast to recommend early acquisition of capital equipment where significant productivity gains can be made.

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2.0 EXECUTIVE SUMMARY (Continued)

2.5.2 Hughes/Government Factory Modernization Program. This program will use the data obtained by the Factory-Wide analysis that has been in progress with the help of the GCA corporation since August, 1983, the five-year manufacturing technology plan presently being created, and the existing manufacturing division capital plans to identify major modernization programs to merge into the AMRAAM Tech Mod and the Tri-Service IMIP.

There are two areas already defined that would fit in this category in which this plan will identify. The first is for AMRAAM Tech Mod which involves the design and development of the "future" factory for rate production. The second is an IMIP "future" factory starting with the IR Maverick rate production needs.

The execution of this data analysis will also result in additional modernization projects which will fit Tech Mod/IMIP.

2.6 Printed Wiring Board Yield Improvements. The short term plan is to create a Printed Wiring Board (PWB) consulting team made up of Tucson and other manufacturing division engineers, a consulting firm, and process material suppliers. The teams charter will be to institute immediate actions to increase yields. The technique to be used in improving the PWB fabrication yields for the long run will be those of the Missile Systems Group Total Quality Assurance (TQA) System. The Missile Systems Group TQA program was started early in 1983 and is made up of a three-phase program. The first phase, which is designed to bring all major manufacturing processes/areas under control, will be selectively used in the PWB area. This dual systematic approach is expected to improve yields and provide a mechanism to maintain them.

2.7 Status Reporting and Corrective Action Systems. The Productivity Plan Quarterly Status Reports will be generated as shown in the Master Schedule in Figure 2.1. This Quarterly Status Report will be in a format similar to this

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2.0 EXECUTIVE SUMMARY (Continued)

2.7 Status Reporting and Corrective Action Systems (Continued)

plan and will report progress as it relates to this program. The first Quarterly Status Report will be submitted with the Productivity Plan.

The development of an internal Status Report and Corrective Action Systems will be accomplished as shown in Figure 7.1. The system will provide a triggering mechanism for areas that are out of control (beyond set targets/goals), capability for variance analysis, a technique for timely reporting to area supervision and the affected management, a running status of each area including indication of out-of-control conditions, and a mandatory cause investigations/corrective actions where chronic out-of-control conditions exist.

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PRODUCTIVITY PLAN

3.0 LABOR PRODUCTIVITY

Figure 3.1 is the Labor Productivity Plan schedule which is described herein. The objective of this plan is to conduct labor productivity evaluations which will:

- Provide immediate insight regarding major factors contributing to existing performance levels
- Facilitate both immediate and long-term corrective action
- Result in quantifiable performance objectives
- Define the required support systems to assure continuing performance to these targets.

To effectively address labor productivity, the interrelationships between work availability, on-board manpower, attainable performance levels to standard and labor utilization must be evaluated as a single dynamic system. The focus of this study will embrace these key components and the related system support functions necessary to provide management/supervisory visibility and controls. Key management and technical resources have been assigned from the manufacturing organization of Industrial Engineering, Production/Material Control, Systems and Procedures, and Project Management to support this productivity analysis.

Labor utilization studies will be conducted by an outside consultant to assure an objective evaluation of operator idleness and causative factors.

Our three major assembly projects: TOW, Phoenix, and T.V. Maverick have been selected for evaluation, analysis, and target setting over the October/November time period. These specific project areas were chosen as they currently represent aproximately 40% of our total touch labor force (fabrication, assembly, inspection, and test) and have historically reflected less effective labor utilization than the other touch labor population. The results of these initial studies will serve as a baseline for establishing performance targets throughout the touch labor force. These surveys will be continued over the period of January through June, 1984.

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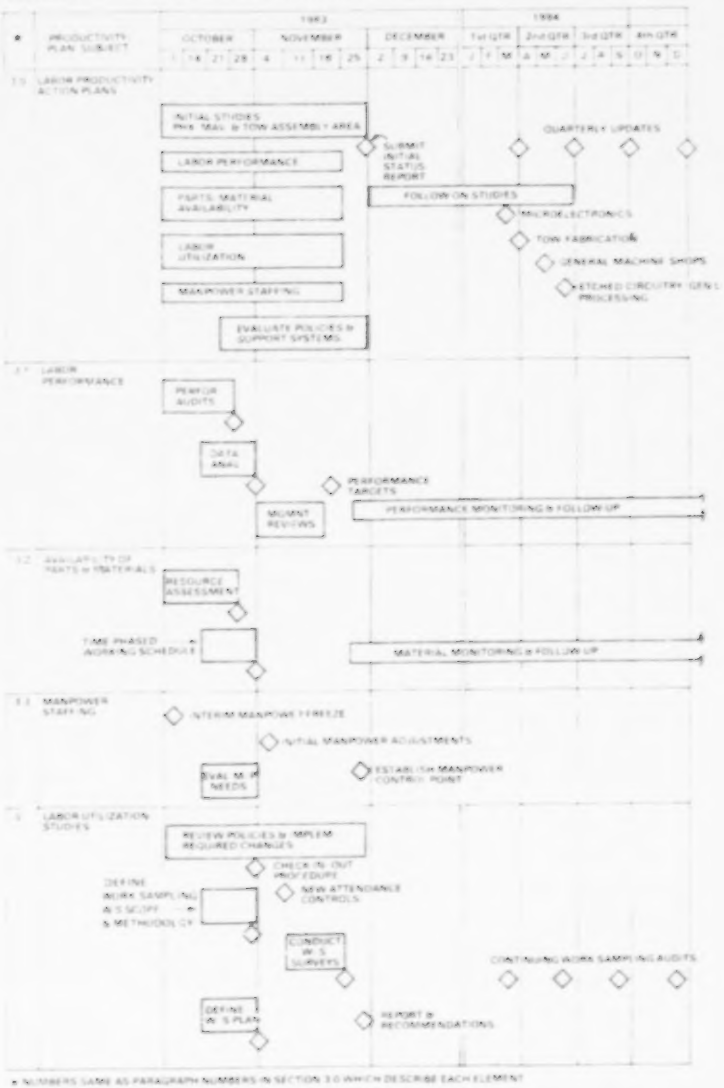

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FIGURE 3.1 LABOR PRODUCTIVITY PLAN SCHEDULE

3.0 LABOR PRODUCTIVITY (Continued)

Microelectronics - January 03 through February 25

TOW Fabrication - February 15 through March 31

General Machine Shops - March 21 through April 29

Etched Circuitry & General Processing - April 18 through June 13

The four evaluation elements of labor performance, availability of parts and material, manpower staffing, and labor utilization are described below.

3.1 Labor Performance. Touch labor performance audits will be conducted by our industrial engineering staff over the first three weeks of October. These studies are designed to provide rapid identification of currently attainable performance levels.

Floor to floor time audits (time from start to finish on a given part or assembly) will be conducted on a representative sampling basis in each individual department. These audits will provide immediate visibility with regard to the operator's performance to "standard and pace" when parts, tools, materials, and equipment are available for work. Completed audits will be normalized to reflect 100% pace and personal fatigue and delay (PF&D) allowances of 15%. The normalized sample observations will then be extended across the remaining non-sampled work on the basis of similarity within each individual department. With this data, a relatively precise assessment of currently attainable "run" performance to standard will be defined.

In addition to run time performance, an evaluation of off-standard factors such as set-up time, material handling time, and rework activity will be conducted using historical data, floor observations and supervisory input. When these factors are added to the run performance data, a meaningful total performance target can be defined. Targets will then be established at the department level and for the total program. These target indices, when coupled with material availability, will be used to determine staffing requirements.

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3.0 LABOR PRODUCTIVITY (Continued)

3.2 Availability of Parts and Material. Concurrent with the labor performance audits, production control personnel will be tasked to inventory resources available for work and to project the availability of additional work over the next six months. This assessment will be developed at the individual part number/department level and converted to workload forecast in terms of standard hours per month.

3.3 Manpower Staffing. Upon completion of the material resource assessment, available work will be extended by the labor performance data described in paragraph 3.1 and the staffing plan adjusted. A temporary hiring freeze was placed in effect on October 3, 1983 pending the installation of an improved system for manpower planning.

3.4 Labor Utilization. During the month of October, the scope and methodology for a comprehensive work sampling survey program will be defined. Booz-Allen and Hamilton will conduct this independent survey, where work practices, productive and non-productive time will be determined and causative factors identified. The survey will be conducted after the staffing adjustments described in paragraph 3.3, thus providing immediate feedback of our performance at these new manpower levels. This work sampling data will be compared to industry norms and converted to idle time content to permit a comparison of our current situation with the previous DCAA audit of February, 1983.

Policies for control of absenteeism are being revised. The new policy will strengthen our ability to take appropriate corrective action and provide improved attendance visibility as employees are transferred between major work centers. Renewed emphasis will also be placed on the requirement to advise the responsible first line supervisor any time the employee leaves or returns to his/her assigned work area.

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4.0 WORK MEASUREMENT (Continued)

4.1 Work Measurement System Study (Continued)

These studies will serve to identify the range of industry practices, the industry norms and the relationship of system design to performance values. The names of the companies that responded will be kept confidential to Lester B. Knight and Rath-Strong.

An analysis of this information will be utilized to assure that any recommended changes in the existing Hughes system reflect accepted industry practices.

4.2 TOW Missile - Macro Analysis. The TOW Missile program representing a comparatively high rate and mature production system has been selected as a benchmark study project to test expected versus realized labor performance.

This macro study will be conducted by the consulting firm of Rath and Strong and will address:

- o Comparison of current labor performance to expected labor performance given the existing product design and program maturity
- o Comparability of TOW labor indices to industry norms on programs of similar maturity
- o Compatibility of TOW performance measurement system to industry norms
- o Recommendations to achieve improved labor productivity.

4.3 Validation/Upgrade of Standards. Figure 4-1 shows the validation/upgrade of the standards plan. The purpose of this plan is as follows:

- o To assign a team of dedicated Hughes industrial engineers with the single task of upgrading and validating as many standards as possible in the next five weeks. The team will be comprised of thirteen members from other

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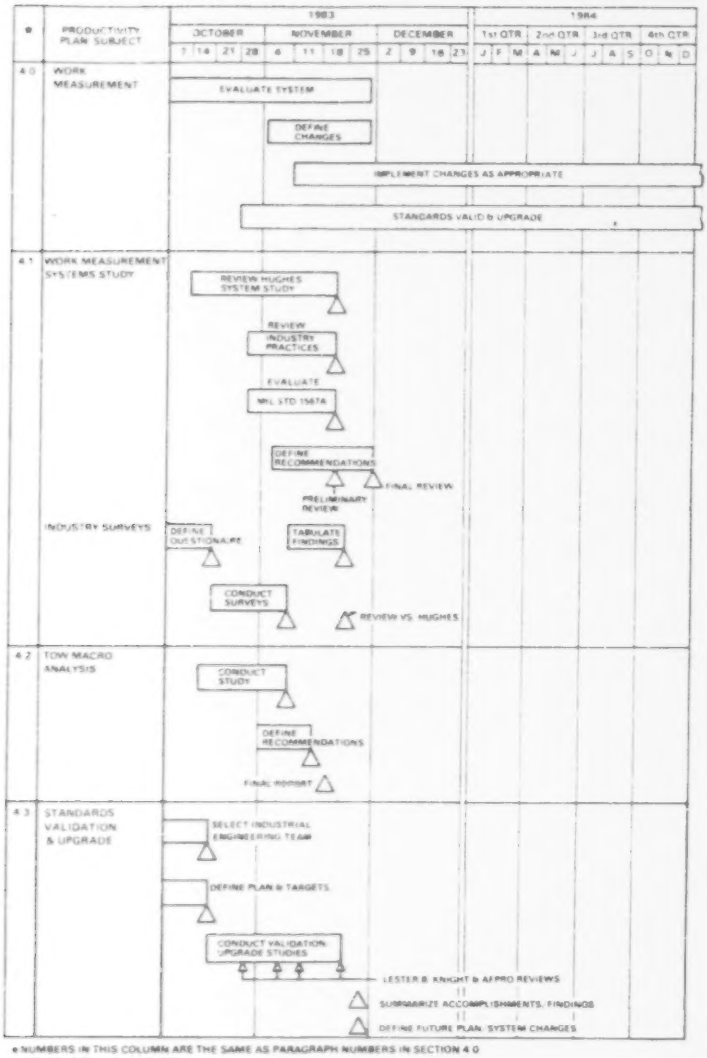

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FIGURE 4.1 WORK MEASUREMENT PLAN SCHEDULE

4.0 WORK MEASUREMENT (Continued)

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4.0 WORK MEASUREMENT (Continued)

4.3 Validation/Upgrade of Standards (Continued)

Hughes Divisions and two members of the Hughes Tucson Division acting as team managers. Team members will be selected from the Santa Barbara Research Center, Radar Systems Group, Electro-Optical Data Systems Group, and from the Ground Systems Group. The team will be screened, using pace rating film techniques to assure that, in addition to their credentials, all members are current and qualified in time study applications

- Targets of 200 to 300 validation and 200 to 250 upgrades will be established and areas defined in which the validation task and upgrade task could be accomplished. This will require a review of operations and material availability which are in progress, with enough activity taking place in the selected operations to assure a adequate sample for proper validation and upgrade accuracy

- An outside industrial engineering consultant firm, Lester B. Knight and Associates, Inc., will be tasked with overviewing the Hughes team efforts to provide guidance and a credibility assessment of their efforts. Weekly reviews will be scheduled with the local AFPRO, Hughes Aircraft, and Lester B. Knight to review progress to date. In addition, Lester B. Knight will be tasked with the assignment of reviewing the current established policies, procedures, and systems used in the current validation and upgrade process, recommending changes to the current system where applicable, and recommending steps to perform annual standards validations

- As an added, but separately identified element, the same policies, procedures, and systems will be analyzed by Lester B. Knight to determine the current established system's compatibility with MIL-STD-1567A, and provide recommendations for the necessary changes to assure compatibility to the contractual requirements.

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4.0 WORK MEASUREMENT (Continued)

4.3 Validation/Upgrade of Standards (Continued)

- o Establish long-term goals for upgrade of standards from Type II to Type I on current programs with the emphasis on I.R. Maverick Program. Establish a plan for a methods review analysis on TOW, select areas of the Phoenix program, and common hardware items between T.V. Maverick and I.R. Maverick.

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4.0 WORK MEASUREMENT (Continued)

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Hughes Divisions and two members of the Hughes Tucson Division acting as team managers. Team members will be selected from the Santa Barbara Research Center, Radar Systems Group, Electro-Optical Data Systems Group, and from the Ground Systems Group. The team will be screened, using pace rating film techniques to assure that, in addition to their credentials, all members are current and qualified in time study applications

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4.0 WORK MEASUREMENT

An analysis of the existing work measurement methodology will be undertaken to determine the adequacy of the system as a management tool, the comparability of the performance measures to the industry norms, and to assure compliance with MIL-STD-1567A as applicable. Three basic tasks will be initiated with each schedule in Figure 4.1.

- o Analysis of the Tucson existing system with industry surveys structured to identify the make up of the typical work measurement system
- o A Tow Missile Macro analysis (labor "should cost")
- o An accelerated standards validation and upgrade effort.

4.1 Work Measurement System Study. The consulting firm of Lester B. Knight and Associates has been selected to conduct an assessment of the Hughes Tucson Missile System Groups current work measurement system.

This evaluation will serve to:

- o Define both the work content included in our labor standards and the total actual time measured against the standard to determine performance indices
- o Compare the Hughes Tucson system to industry practices
- o Evaluate the requirements imposed by MIL-STD-1567A
- o Recommend changes in the existing system which will improve management visibility and controls, reflect industry practices and comply with established contractual requirements.

The consulting firms of Lester B. Knight and Rath-Strong have been chartered to define a common questionnaire and conduct industry surveys establishing work measurement practices and historical performance to standard when related to a given work measurement system design.

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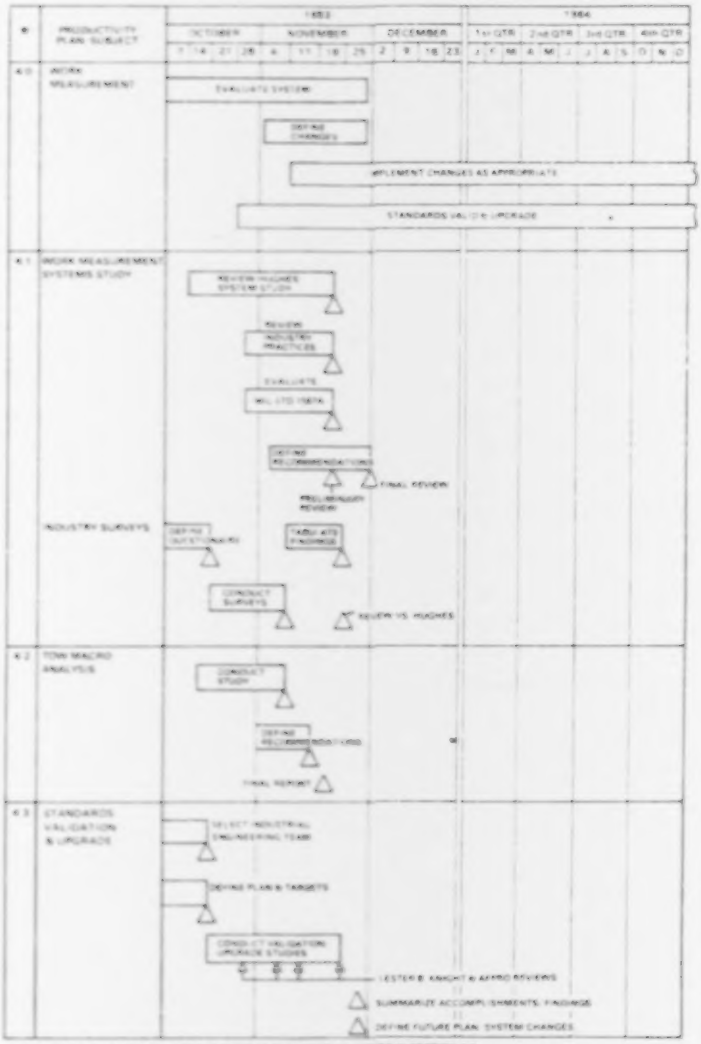

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FIGURE 4.1 WORK MEASUREMENT PLAN SCHEDULE

4.0 WORK MEASUREMENT (Continued)

4.1 Work Measurement System Study (Continued)

These studies will serve to identify the range of industry practices, the industry norms and the relationship of system design to performance values. The names of the companies that responded will be kept confidential to Lester B. Knight and Rath-Strong.

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4.0 WORK MEASUREMENT (Continued)

4.3 Validation/Upgrade of Standards (Continued)

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- As an added, but separately identified element, the same policies, procedures, and systems will be analyzed by Lester B. Knight to determine the current established system's compatibility with MIL-STD-1567A, and provide recommendations for the necessary changes to assure compatibility to the contractual requirements.

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4.0 WORK MEASUREMENT (Continued)

4.3 Validation/Upgrade of Standards (Continued)

- o Establish long-term goals for upgrade of standards from Type II to Type I on current programs with the emphasis on I.R. Maverick Program. Establish a plan for a methods review analysis on TOW, select areas of the Phoenix program, and common hardware items between T.V. Maverick and I.R. Maverick.

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5.0 OFFLOAD/FACILITY SPACE

The schedule shown in Figure 5.1 represents the plan to re-evaluate the current offload policy, make/buy plan, potential relocation of administrative functions, and the five-year facility plan. The objective of this re-evaluation will be to recommend changes that would reduce the currently projected requirements for additional Air Force facility construction at USAF Plant 44.

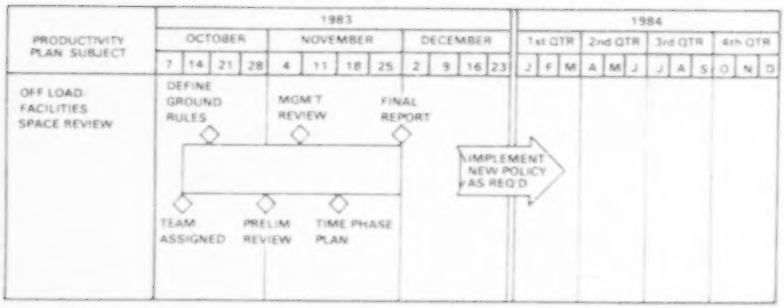

FIGURE 5.1 OFFLOAD/FACILITIES SPACE PLAN SCHEDULE

In order to accomplish this re-evaluation, a team is to be assembled that represents the key project/functional areas which generate space requirements.

The team members will be comprised of managers from the TOW, Maverick and Phoenix project groups, and from the materiel, industrial engineering, and facilities organizations. The team will be responsible for:

1) Defining the ground rules and assumptions for baselining the re-evaluations
2) Selecting the candidates for changes to the current offload and Make/Buy Plan

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5.0 OFFLOAD/FACILITY SPACE (Continued)

3) Recommending candidates for offload to feeder plants or other Hughes facilities

4) Quantifying the space requirements associated with each candidate

5) Coordinating the selected candidates through the management review and approval cycle

6) Establishing the time frame required to implement the recommended changes

7) Reviewing their recommendations with Division management

8) Preparing a final report documenting their analyses, recommendations, and conclusions.

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6.0 MANAGEMENT

Figure 6.1 illustrates the plan for organizational analysis and changes and the commitment to improving Operational activities with the use of Total Quality Assurance.

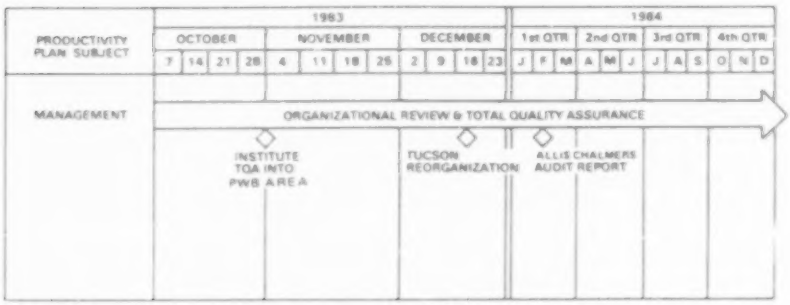

FIGURE 6.1 MANAGEMENT PLAN SCHEDULE

The Corporate, Group, and Division management are making a detailed organizational review and associated personnel assessments.

The company has instituted a corporate policy utilizing Total Quality Assurance (TQA) philosophies. The Missile System Group has embraced this concept by requesting the Allis Chalmers Corporation to review the groups operation with the intent of recommending changes to accomodate TQA. Allis Chalmers is not a TQA Consultant, but rather a firm that has successfully and gainfully implemented a TQA system in their facilities. Their experience will be of great value in implementing the Missile System Group TQA System. Allis Chalmers will provide a report of their findings in early February, 1984. As part of Section 8.0, TQA will be introduced with Printed Wire Board Area for long-term improvement and maintenance of yields.

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7.0 FACTORY MODERNIZATION

The schedule shown in Figure 7.1 represents the plan for factory modernization. The factory modernization productivity plan will be developed through the analysis and integration of three key elements: 1) identification of factory needs and high cost areas, 2) development of a plan for manufacturing technology growth, and 3) an understanding of the existing plans relating to capital procurement. From this integrated analysis, the Hughes modernization plan can be merged with the government sponsored Tech Mod and Industrial Modernization Incentive Programs. The government-sponsored programs which affect Hughes Tucson are: 1) AMRAAM Tech Mod, which is under contract and 2) the Tri-Service Factory-Wide Industrial Modernization Incentive Program (IMIP) which will be on contract in March, 1984. The following paragraphs describe this review process and the expected results as they impact Tech Mod and IMIP.

7.1 Industrial Modernization Review Process. The review of the factory-wide analysis, the five-year industrial technology development plan and the Hughes Tucson capital plan will provide the necessary data to merge the Hughes modernization plan with Tech Mod and IMIP. The elements to be analyzed are described below.

7.1.1 Factory-Wide IDEF analysis. The factory-wide IDEF analysis started in August, 1982 under the guidance of the GCA corporation and is being performed by Hughes at this time. The purpose for performing this analysis is to develop projects for IMIF that will provide high productivity gains. The initial effort is to model the existing factory elements to obtain the "as is" architecture. The next step is to identify the "needs" of the factory. This is done through personal interviews and through labor cost identification. The final step is to generate the "to be" architecture that will satisfy the "needs." The report of the factory-wide analysis will be complete at the end of the year.

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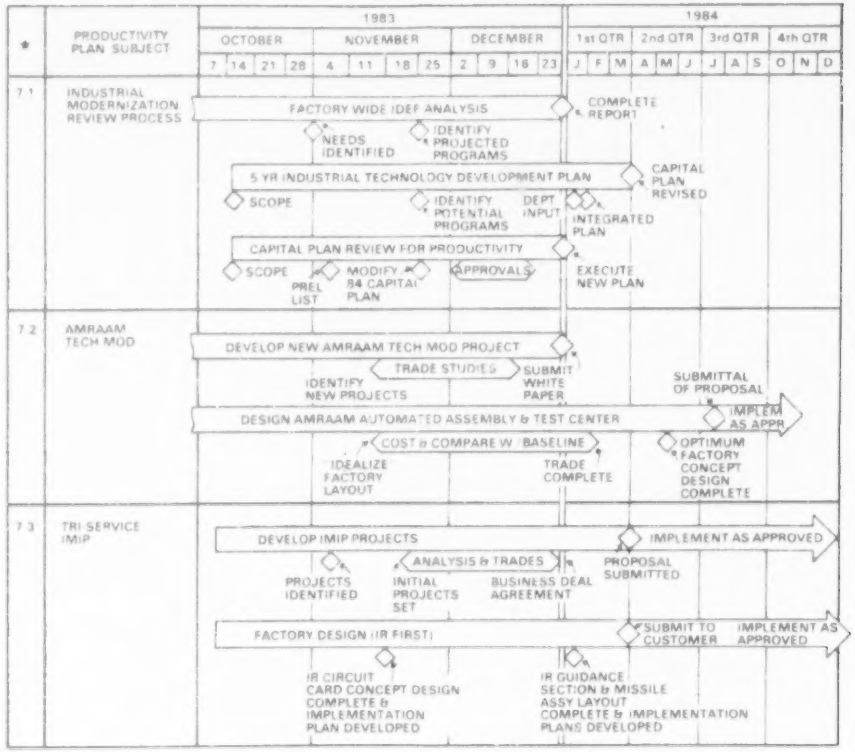

* NUMBERS SAME AS PARAGRAPH NUMBERS IN SECTION 7.0 WHICH DESCRIBE EACH ELEMENT

FIGURE 7.1 FACTORY MODERNIZATION PLAN SCHEDULE

7.0 FACTORY MODERNIZATION (Continued)

7.1.2 Five-Year Industrial Technology Development Plan. To integrate the plans of each manufacturing engineering organization, a formalized plan for industrial technology development will be generated. This plan will integrate the forecast, philosophies, and visions of the manufacturing organizations involving material handling, assembly, fabrication, processing, test, inspection, production control and business systems. This formal plan will itemize and calendarize each technology development task. Execution of the plan will be managed by the newly formed Advanced Manufacturing Technology Department.

7.1.3 Capital Plan Review for Productivity. The existing capital procurement plans will be reviewed by each manufacturing engineering discipline and the manufacturing systems department with the intent of accelerating the acquisition of capital equipment where significant productivity gains can be obtained. The productivity gains expected will come in areas affecting floor operation cost through increased quality, reduced failure rates, fast response times, elimination of manpower, reduction of operation times and operational efficiencies.

7.2 AMRAAM Tech Mod. This government program is under contract. The task described in section 7.1 will enhance the performance of the AMRAAM Tech Mod Program. The integrated analysis will identify areas within the AMRAAM manufacturing/test that can be improved through technology modernization. These identified areas will be studied and subsequently introduced into the Tech Mod program through "White Paper" submittals and subsequent project proposals. One major project which has been started (September, 1983) is the conceptual design of the AMRAAM Automated Assembly and Test Center. The technique being used to create the design is graphically described in Figure 7.2.

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7.0 FACTORY MODERNIZATION (Continued)

7.2 AMRAAM Tech Mod (Continued)

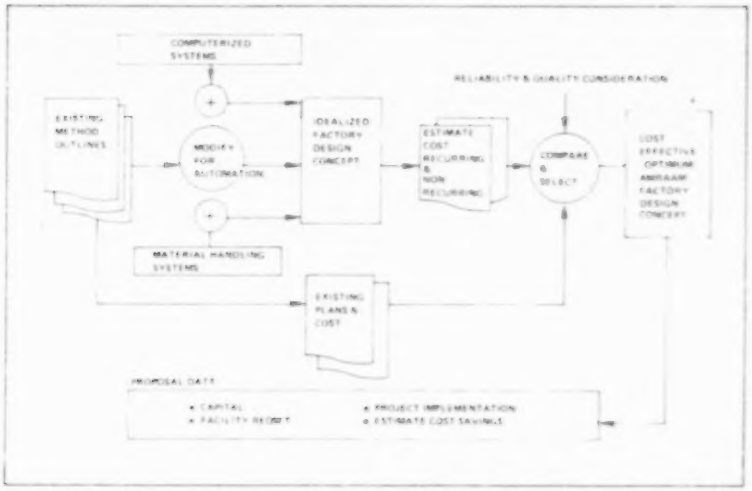

FIGURE 7.2 AMRAAM ASSEMBLY/TEST CENTER CONCEPTUAL DESIGN PROCESS

The essence of this technique is the development of the "idealized" factory with no regard to cost effectiveness and technical ease. The "idealized" factory is then compared from a cost, reliability and quality standpoint with the plans that presently exist for AMRAAM rate production. This comparison will result in an optimum design that will be proposed (in whole or in part) as an AMRAAM Tech Mod project.

The "idealized" factory layout will be available for review by the submittal of the first Quarterly Status Report.

7.3 Tri-Service IMIP. This Tri-Service IMIP is presently being developed and will affect the TOW, Maverick, Phoenix and AMRAAM programs. The business arrangements are in the process of being negotiated with the IMIP Systems

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8.0 PRINTED WIRING BOARD YIELD IMPROVEMENTS

The schedule shown in Figure 8.1 represents the plan to perform a detailed analysis of the printed wiring board facility, processes, methods and documentation.

A team of specialists will be formed to perform the analysis. The team will be composed of printed wiring board Hughes process engineers from the Ground Systems Group, Radar Systems Group, and Missile Systems Group; technical support engineers from Missile Systems Group Materials Laboratory; product assurance engineers from Missiles Systems Group; production supervisors and a statistical analysis engineer from the Tucson Division.

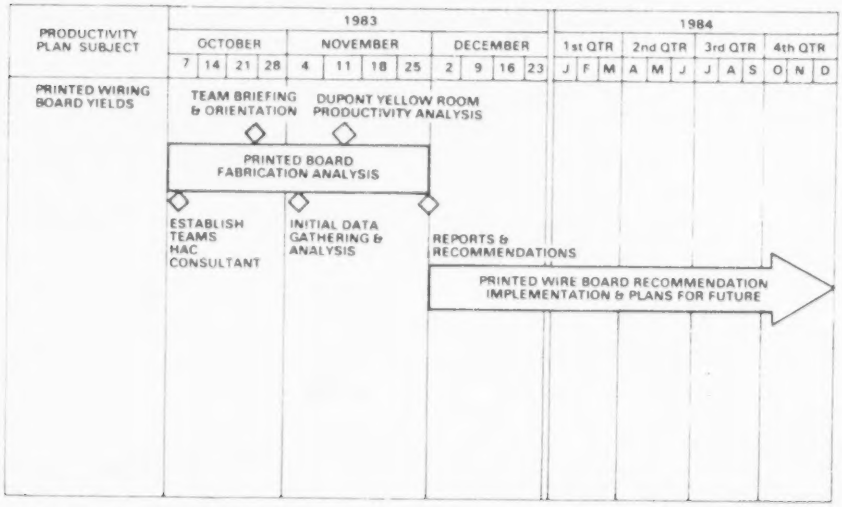

FIGURE 8.1 PRINTED WIRING BOARD YIELDS IMPROVEMENT PLAN SCHEDULE

The consulting firm of Rath and Strong, Inc. is retained to provide an independent but parallel assessment of the printed wiring board processes and to conduct an industry survey to determine printed wiring board fabrication yield norms for similar products manufactured to the same as or "equal to" specifications as those in Tucson.

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7.0 FACTORY MODERNIZATION (Continued)

7.3 Tri-Service IMIP (Continued)

Program Office (SPO), USAF Armament Division, Eglin AF Base, Florida. The business deal and subsequent contract is planned to be finalized in March, 1984 in conjuction with the submittal of the first set of project proposals. The efforts described in paragraph 7.1 (Industrial Modernization Review Process) will result in identification of projects that are shared by several of the programs that will be submitted as IMIP proposals. One of the major projects that will be part of the IMIP program is an automated factory design starting with the IR Maverick program. Since the IR Maverick program has high rate projections and is in its pilot production phase, it is the prime candidate for initial installation of future factory technology. The plan for development of the conceptual design of the IR Maverick production line is shown in Figure 7.1. The circuit board assembly and test area will be designed first, with guidance unit and missile assembly/test coming next. The fully automated circuit board line will be laid out and a plan to phase it in to Segment III, IV, and V production will be available in time for the first Quarterly Status Report submittal. The remaining assembly and test area plans will be available by the second Quarterly Status Report. Other projects suitable for IMIP will be identified and described in the first Quarterly Status Report.

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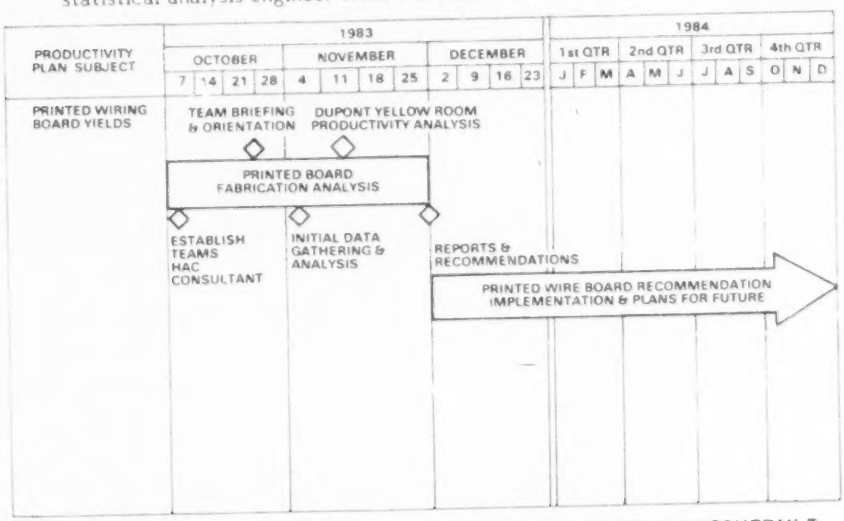

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8.0 PRINTED WIRING BOARD YIELD IMPROVEMENTS (Continued)

Assisting the Hughes team of specialists will be experienced personnel from the manufacturers of chemicals and materials used in the printed wiring board industry. These manufacturers will make independent evaluations of the equipment, methods and materials applicable to their area of expertise. Among these manufacturers are: Dupont, Riston Division; MacDermid, Electronic Products Division; and Norplex, Laminate Division. The initial task of this team is to review all materials, processes equipment, building, methods documentation data systems, specifications and related personnel skills in order to identify the inadequacies which could contribute to lower than desired printed wiring board yield and improvements that can be implemented to increase productivity and product quality. The longer term goal is to recommend, initiate and implement corrections and controls which will effectively improve and stabilize the printed wiring board (PWB) yields.

Part of the technique to be used in improving and maintaining the PWB fabrication yields for the long run will be those of the Missile Systems Group Total Quality Assurance (TQA) System. The Missile Systems Group TQA program was started in early 1983 and consists of a 3-phase program. The first phase, which is designed to improve all major manufacturing processes/areas and maintain their control, will be selectively applied in the printed wiring board area.

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